

MILITARY OPERATIONS RESEARCH SOCIETY



Analyzing Effects-Based Operations Workshop Report

29-31 January 2002

Booz Allen Hamilton, McLean, Virginia

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This Military Operations Research Society report summarizes the proceedings of a workshop conducted over three days by experts, users and participants interested in effects based operations. It is not intended to be a comprehensive treatise on the subject. It reflects the major concerns, insights, thoughts and directions of the participants at the time of the workshop.

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WORKSHOP SUMMARY

BACKGROUND

A MORS Workshop on Effects-Based Operations (EBO) was held 29-31 January 2002. 177 analysts and decision makers participated. This number included nine foreign nationals and produced 61 new MORS members. This summary outlines the purpose, findings and recommendations of the workshop.

PURPOSE

The original concept for MORS holding a workshop on Analyzing Effects-Based Operations arose more than a year before the meeting was held and focused on the very real question of whether EBO was a useful concept at all. Over the past year the concept has been maturing and more and more organizations have begun taking it seriously. Nevertheless, the four key issues the workshop was asked to address were:

1. What does the phrase "Effects-Based Operations" mean?
2. What analytic challenges does it present to the Operations Research (OR) community?
3. What approaches and tools already exist that offer promise in meeting those challenges?
4. What actions should the OR community recommend in order to ensure quality analyses in support of effects-based operations?

The workshop was successful in generating quality responses to all four issues, though the results also highlight the fact that a great deal more needs to be done. The effort profited greatly from rich work group efforts. The working group structure is shown in Figure 1.

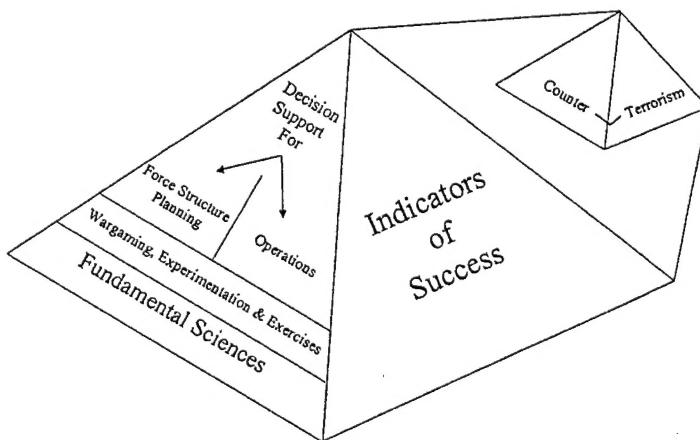


Figure 1. The Working Group Structure

WHAT IS EBO?

Consensus emerged that warfare, particularly effective warfare, has always been effects-based. Sun Tzu, Genghis Khan, Napoleon, Eisenhower and Schwartzkopf all would be familiar with the principles that warfare should include all the instruments of national power and that each instrument should be applied in a way that maximizes its desirable impacts, minimizes undesirable ones, and complements actions taken in other arenas. These basic principles, which define the essence of EBO occur in a context that makes them particularly relevant today. First, we have the means to gather, integrate, and apply more data, information, and knowledge than analysts and policy makers in earlier eras — we are in the “Information Age.” Second, we live in a world that is more tightly coupled than ever before, creating opportunities and challenges for both direct and indirect, desirable and undesirable effects. EBO permits us to seek more efficient ways to achieve national goals and allows us to consider shaping the environment in order to minimize challenges to US interests. EBO does not exclude, and cannot properly be contrasted with, either kinetic weapons or attrition, as they are tools that may be used to achieve desired effects. Ultimately, the “effects” sought will be behavioral, but that may arise from altering the adversaries’ capabilities or will. EBO does tend to focus greater attention on will, but not to the exclusion of altering the capabilities of adversaries, partners or neutrals.

Two crucial differences between EBO and the ways we have been thinking in the past emerged from the discussions in the workshop:

1. Effects-Based Operations challenge us to move from an era of increasing Jointness to an era of “Meta-Jointness” that integrates DoD’s actions into coherent sets of actions that involve a broader set of participants (e.g., interagency and coalition partners, International Organizations (IOs), Non-Governmental Organizations (NGOs)).
2. Effects-Based Operations require both greater knowledge and greater capability to deal with uncertainty than traditional military operations.

In the words of plenary speakers at the Workshop, EBO therefore becomes “a way of thinking” (Major General Deptula, USAF), “a common frame of reference between DoD and other agencies” (Graham Kessler, J9, JFCOM), and it “coordinates sets of actions directed at shaping the behavior of friends, foes, and neutrals, in peace, crisis, and war” (Ed Smith, Boeing).

KEY ATTRIBUTES OF EBO AND THE CHALLENGES THEY IMPLY

Effects-Based Operations draw most of their key characteristics from the environments in which they are needed. Classic EBO problems are:

- Multi-disciplinary: with partners, adversaries, and neutral parties involved and perceived to have important interests in the situation.
- Multi-dimensional: political, military, social, economic, information, legal, and humanitarian factors are often all highly relevant.

- Multi-echelon: cutting across the boundaries between strategic, operational, and tactical arenas.
- Perception driven: each actor will see a somewhat different situation and is likely to interpret actions in somewhat different ways.
- Dynamic: changing over time, such that even the interests and goals of the parties will change during the operations.
- Characterized by adaptive behavior: all the parties are likely to learn during an EBO, or from a prior EBO, and alter their behaviors accordingly.
- Non-linear: such that small actions or changes in behaviors may lead to dramatic impacts.
- Involve both massive and sparse data regions: some aspects of EBO occur in problem spaces with so much data that they defy integration and comprehension, but other important aspects occur where little or no quality data exist.
- Uncertain: despite the fact that EBO are often associated with floods of data and information, they are also typically associated with great uncertainty about key items of information and knowledge.
- Probabilistic: simple cause and effect patterns may be very difficult to detect given the number of relevant factors and the degree of uncertainty, forcing EBO analysts to employ probabilistic approaches and tools.

In short, EBO today take place in a highly complex, multi-dimensional environment. In addition, ideal EBO are highly efficient — achieving basic goals with limited investments and calculated risks to lives and national treasure. Taken together, the attributes of EBO and the situations in which they take place constitute a major challenge to the analytic community.

The workshop paid particular attention to Measures of Merit (MoM) and indicators of success. These represent a meaningful challenge in EBO. First, they were seen as heavily situation dependent, though the hope was expressed by those working the issue that classes of situations could be associated with families of metrics. However, the most profound challenge in this arena is a cultural change within DoD — persuading military decision makers that they ultimately must support Measures of Policy Effectiveness (MoPE), not limiting themselves to Measures of Force Effectiveness (MoFE). This, of course, greatly complicates analyses to support EBO.

EXISTING APPROACHES, TOOLS AND TECHNIQUES

On one level, consensus existed across the plenary sessions and the working groups about the kinds of approaches that are needed to perform analyses in support of EBO.

Qualitative approaches may be necessary because not all the issues can be handled using quantitative tools. Analyses often will be exploratory, ensuring a rich understanding of the problem space and helping us see what can happen rather than predict precisely what will happen. Analysis will be probabilistic rather than deterministic. Decomposition will be employed in order to make research issues more tractable, but reaggregation to create a holistic understanding of the problem will remain essential and challenging. Paul

Davis' (RAND) call for "multi-perspective, multi-resolution models" resonated with many of the workshop participants, who see EBO as too difficult to support with individual tools. Optimization may be neither practical nor essential. Instead, decision makers are likely to opt for different decision logics, such as strategies that allow them to avoid disaster with high confidence while increasing the likelihood of success, or buying more time to reshape an unfavorable situation. Approaches that help to visualize EBO, to track resource allocation within EBO, and to trace effects (second and third order, cascading effects, etc.) also would be valuable.

Several specific tools that show promise for EBO applications were identified. The most mature were built on influence networks, which represent expert opinions that can be examined in detail and experimented with through sensitivity analyses. In turn, the most mature of these have been implemented in conjunction with colored Petri nets to map them into integrated plans of action. Computational social science tools also were identified as a good match to the EBO arena, as were complex adaptive systems employed in state space analyses (chaotic control theory and evolutionary game theory), but these tools have not yet been applied directly in the EBO arena. Initial efforts using agent based models and neural networks were reported as promising in briefings to working groups, but are still in the research and development stages. Leontief input-output analysis, well established in economic analyses, were shown to be a good match to the EBO problem space, but cannot be applied unless quality data are available and the behaviors (changes in resource allocations) of non-market states can be forecast intelligently.

Finally, a number of research techniques were endorsed by the plenary speakers and the working groups. These included mining history (both to generate rich understandings of specific situations and the actors relevant to them, and to understand the dynamics associated with different instruments of influence and power), structured games (both war games and games that focus on broader interactions), and structured campaigns of experimentation.

WORKSHOP RECOMMENDATIONS

Effect-Based Operations, as a broad organizing concept, appears promising as an approach that will help decision makers in DoD and other organizations in the national security arena to protect US national interests and achieve US goals. The Workshop identified a number of tools and approaches that appear promising to support EBO.

However, this will require several important changes. These include:

- Education of both the decision making and analytical communities about EBO, including what it means and what it will take to implement it.
- Improved sharing of information, knowledge, training, planning, execution, and feedback across all the organizations that must participate in an EBO (e.g., the intelligence community, DoD, the National Security Council, and the other Departments and Agencies in the national security committee).
- Adoption of MoPE and indicators of EBO success as the dominant focus of analysis.

- Deployment of multi-disciplinary analytic teams with military headquarters employing EBO to ensure responsive support, educating the analysts about real world problems, and enabling effective linkage to technical communities.
- Broadening and deepening the expertise (substantive and analytical) available to support EBO, including tools for information sharing, research, and collaboration. This includes more interdisciplinary work that involves more social scientists, area specialists, and non-military practitioners (e.g., NGO, IO, business) in the community, broader training of OR professionals in the “soft” areas, as well as creating the capacity (e.g., reach back, reach out, intermediary organizations such as CINCPAC’s Virtual Information Center) to use their expertise during EBO.
- Creation of databases and data structures designed to support EBO and the networks EBO seeks to impact. At the same time, adaptation of data mining techniques to permit efficient application of these techniques.
- Support efforts to develop and employ EBO analyses with an integrating mechanism, similar to the Command and Control Research Program of the ASD/C3I, that acts to stimulate, coordinate, and integrate relevant activities across government, industry, academia, and coalition partners. This should include activities to create an EBO community, such as websites, workshops, symposia, and publications.
- Develop a “tool chest” to support EBO analyses that includes easily manipulated, specialized modeling and simulation tools, computational social science tools, data mining, colored Petri nets, neural networks, and specialized tools developed in particular application arenas (e.g., counter-terrorism, persuasive communication, economics). This tool chest should be assembled in evolutionary fashion, creating a core capability from “best of breed” products and refining and expanding the tool chest to reflect user feedback and the results of research.
- Establish, for both exploratory research and training purposes, a series of wargames and experiments to explore the EBO field, make practitioners more comfortable with the topic, and allow rapid analyses of new challenges and situations where shaping or coercive diplomacy appear promising.

We still have a long way to go to address the issue of Analyzing Effects-Based Operations. One of the Synthesis Group recommendations was that MORS should schedule a follow-up meeting in two years to discuss progress in Analyzing EBO.

MEETING DESCRIPTION

The meeting was held at Booz Allen Hamilton on 29-31 January 2002 and was structured as a combination mini-symposium and workshop. The mini-symposium on the first day featured papers to bring us up to speed on the state of the art on EBO thinking. The General Chairs, Dr. Jacqueline Henningsen, FS, SES, Director, Air Force Studies and Analyses Agency, and MG Dean Cash, USA, US Joint Forces Command, both provided opening remarks to kickoff the meeting. Table 1 shows the list of speakers and presentations that followed. The keynote address was given by Mr. Len Hawley, former

Assistant Secretary of State, to provide a policy-maker's view. Practical perspectives on EBO were provided by Major General Deptula, USAF, and General Charles Wilhelm, USMC (Ret), who has served as CINC USSOUTHCOM and currently works with J9, JFCOM in developing and experimenting with new concepts such as EBO. Paul Davis of RAND and Lee Wagenhals of George Mason University gave broad presentation that linked EBO to analytic challenges and suggested classes of potentially useful analytic tools. The sequence of technical presentations that followed led into progressively more detail on analyzing EBO. The day concluded with Ed Smith's paper that discussed linking NCW to EBO.

Table 1.

Plenary Sessions	Topics	Presenter
Keynote Presentation	A Policy-Maker's Perspective on EBO	Mr. Len Hawley, Former Assistant Sec of State
Special Presentation	Effects-Based Operations — Change in the Nature of Warfare	Maj Gen David Deptula, USAF, ACC/DO
Special Presentation	Effects-Based Operations: An Operator's Perspective	General Charles Wilhelm, USMC (Ret)
Technical Presentations	EBO: A Grand Challenge for Analysis	Dr. Paul Davis, RAND
	Effects-Based Course of Action Analysis in Support of Wargames	Dr. Lee Wagenhals, GMU
	EBO Concept	Mr. Graham Kessler, JFCOM
	Computational Social Science, Operations Research & EBO	Dr. Desmond Saunders-Newton, ODUSD/AS&C
	Analytic and Philosophical Imperatives of EBO	Dr. Michael Senglaub, Sandia National Labs
	Input-Output Modeling for EBO	Capt Anthony Snodgrass, AFOTEC/TSE
	From NCW to EBO	Dr. Ed Smith, Boeing
	Measuring the Effects of Military Operations	Mr. Barry Watts, OSD(PA&E)

The mini-symposium was followed by a two-day workshop. This began with a special presentation by Mr. Barry Watts (OSD, PA&E) on *Measuring the Effects of Military Operations*. Then the participants met in working groups to examine specific topics. The six working groups were: 1) Decision Support for Operations; 2) Decision Support for Force Structure Planning; 3) Wargaming, Experimentation and Exercises; 4) Indicators of Success; 5) Fundamental Sciences; and, 6) Effects Based Analysis for Counterterrorism. As with all MORS special meetings, a Synthesis Panel was formed to collect and summarize insights from each of the working groups. Table 2 shows the working group leadership which included an excellent group of energetic people. Working group reports were briefed out on Thursday afternoon.

SUMMARY

As a consequence of the Workshop, there is enhanced understanding of the nature of this highly complex and multi-dimensional problem. In addition, we are beginning to gain confidence that our traditional approaches to such problems are viable. However, we are keenly aware of the major challenges that remain in assembling and applying the needed expertise, tools and data to analyze real world operations.

Table 2.

Working Group	Leadership
WG 1: Decision Support for Operations	WG Chair: Col Jose Negron, DARPA WG Co-Chairs: Mr. Bruce Harris, DRC Advisor: Dr. Cy Staniec, Northrop Grumman IT
WG 2: Decision Support for Force Structure	WG Chair: Lt Col Kirk Yost, OSD WG Co-Chairs: Mr. Jim Bexfield, FS, IDA Advisor: Dr. Andy Loerch, GMU
WG 3: Wargaming, Experimentation, and Exercises	WG Chair: Col Steve Pennington WG Co-Chairs: CDR Mike Waldhauser, NWDC Advisor: Dr. Russ Richards, MITRE
WG 4: Indicators of Success	WG Chair: RADM Gary Wheatley, USN (ret), EBR WG Co-Chairs: Corinne Wallshein, AFSAA/SAG Advisor: Mr. Chuck Taylor, Joint C4SIR DSC
WG 5: Fundamental Sciences	WG Chair: Lt Col Steve Rinaldi, AF/XPQI WG Co-Chairs: Mr. Jeff Cares, Alidade Consulting Advisor: Dr. Al Branstein, MCCDC
WG 6: Effects Based Analysis for Counterterrorism	WG Chair: Dr. Randy Pherson, EBR WG Co-Chairs: Lt Col Eileen Bjorkman, DMSO Advisor: Dr. Bob Sheldon, Emergent-IT
Synthesis Panel	WG Chair: Dr. Stuart Starr, FS, MITRE WG Co-Chair: Dr. Roy Rice, TBE

The findings of each of these working group's follow in sequence.

MORS Workshop

Analyzing Effects-Based Operations

Working Group 1 Decision Support for Operations

29 January 2001 through 31 January 2001

Booz Allen Hamilton, McLean, VA



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Working Group 1

- ◆ **The objectives of this special meeting will be to:**
 - Achieve an understanding of the analytical challenge of Effects-Based Operations
 - Explore what tools, data, and metrics exist or need to be developed
 - Relate the concept to what already exists
- ◆ **Task for WG 1: Decision Support for Operations**
 - Group will examine the use of analysis to support the planning and assessment of Effects-Based Operations.



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Working Group 1 Presentations

- ◆ Mr. Larry Willis, DARPA: Wargamming the Asymmetric Environment ... a Predictive Analysis Tool
- ◆ LTC Bob Soniak, USA, DAMO-SSP: Effects Based Planning
- ◆ Mr. Richard Bird, AFSAA: OR Support to the CAOC during AWOS (air war over Serbia)
- ◆ LtCol Tom Tighe, USAF, AFSAA/SAFC and Dr. Clayton Bowen, AFSAA: EBO on a Terrorist Network
- ◆ Mr. Cliff Krieger, DRC and Mr. Bill Plummer, PTI: Civil Environment Model



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Working Group 1 Great Americans +

- ◆ Ms. Cheryl Black
 - ◆ Dr. Clay Bowen
 - ◆ Mr. John Bres
 - ◆ Mr. Joseph Caroli
 - ◆ Mr. Dennis Gleeson
 - ◆ LtCol Bruce Hanessian
 - ◆ Mr. Bruce Harris
 - ◆ Mr. Greg Keethler
 - ◆ Mr. Harry Lesser
 - ◆ Mr. Jerry Levesque
 - ◆ Dr. Andrew Loerch
 - ◆ 2d Lt Alicia McCandrew
 - ◆ CDR Kathleen McGrath
 - ◆ MAJ Gregory McGuire
 - ◆ Dr. Joseph Mickiewicz
 - ◆ COL Jose Negron
 - ◆ Mr. Benjamin Paris
 - ◆ Mr. Sam Packer
 - ◆ Mr. Michael Pinter
 - ◆ LTC Robert Soniak
 - ◆ LtCol Thomas Tighe
 - ◆ Mr. Marty Westphal
 - ◆ Dr. Christopher White
 - ◆ MAJ Robert Wood
- ◆ Honorary Americans:
- ◆ Mr. David Ball (UK)
 - ◆ Mr. Guy Duczynski (AUS)



EBO Definition

Effects-Based Operations (EBO): A methodology for planning, executing and assessing operations [designed to attain the effects] required to achieve desired national security outcomes.

- ◆ Incorporates all applicable elements of national power for a particular situation — military, economic, political
- ◆ Applicable across the full spectrum of activities from peace to war
- ◆ Requires the explicit and comprehensive linking of strategic objectives to each tactical action
- ◆ Uncertainty, friction and adaptive adversaries may trigger additional effects beyond those which are anticipated



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WG 1 Decision Support for Operations Focus Questions

- ◆ How is **analysis** currently used to support the planning and assessment of Effects-Based Operations?
- ◆ What are the **indicators of success** used in the planning and assessment of Effects-Based Operations?
- ◆ What **tools and techniques** are available to apply to this analysis to measure these indicators of success? What shortfalls exist in this set of tools and techniques?
- ◆ What **recommendations** do you have to improve the existing Effects-Based Analysis capability?



WG 1 Decision Support for Operations

Focus Question #1 (Current Analysis)

- ◆ We can do the "physical"-- the "non-physical" is the challenge
- ◆ Support for the planning process exists, but greater value may rest with the commander's decision making process
- ◆ Need analysis and assessment to link COPs/FOPs to desired end state of the phase of the operation (key is to highlight risks and opportunities)
- ◆ Appears to be too much ad hoc analysis
- ◆ Most assessment appears anecdotal
- ◆ Some analysis used in deliberate planning but most tools attrition based (what is the value of LER in humanitarian assistance?)
- ◆ Network nodal analysis used in OOTW (UK)
- ◆ Tasks are tracked to strategy (UK)
- ◆ Strategy is tracked to tasks (US)
- ◆ Collateral damage risk assessment and "rebuttal cell" (UK)
- ◆ Tend to "look back" at analysis once an advantage is achieved
- ◆ Analysis too often stove piped (Service-centric, Intra-DoD, Intra-coalition, NGOs)
- ◆ Cubicle warfare – warriors and analysts too often "toss" analytical problems back and forth
- ◆ Too heavy a focus on military rather than holistic solutions (State, Intel, Log, etc.)



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WG 1 Decision Support for Operations

Focus Question #2 (Indicators of Success)

- ◆ Achieving the desired end state
- ◆ Recognition of the quantitative/qualitative components of effects
- ◆ “Expert” consensus on the “hard” problems
- ◆ Observables beyond the traditional tanks, planes and ships (measuring departure from norms of daily life)
- ◆ Achievement of the plan
- ◆ Positive “CNN effect” (TV and print coverage) in terms of content and duration of coverage
- ◆ Number and degree of predictions met
- ◆ Must be situation-specific: based on commander’s intent but factoring in positive and negative effects of relevant actions and operations
- ◆ Movement from the “smoking hole” mindset
- ◆ More open acceptance of the “other” effects (political/military/public/social “will”)
- ◆ Appreciation of the ambiguous or soft metrics of information operations



WG 1 Decision Support for Operations

Focus Question #3 (Tools and Techniques)

- ◆ There are tools:
 - DARPA Predictive Analysis Tool
 - PRISM (intelligence analysis tool at NGIC): complexity-based approach
 - DIAMOND (UK- normality indicators)
 - Physical to functional damage transfer function trees (UK)
 - AFRL Causal Analysis Tool
 - GMU's CAESAR/EB (outgrowth of SIAM): influence nets
 - AFRL Strategy Development Tool (under development)
 - Civil Environment Model (component of NASM)
- ◆ There are MORE tools: Identified 192 “candidate” tools in recent DMSO study on candidate OOTW tools



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WG 1 Decision Support for Operations

Focus Question #3 (Tools and Techniques)

- ◆ There are shortfalls:
 - Need data fusion/knowledge integration tools to support decision making
 - Need greater use of graphical representation (symbols) to present desired and unintended effects
 - Lack of common semantics and syntax
 - Absence of recommended practice guides to facilitate interoperability
 - Models behind the Green Door – lack of web-site tutorials and FAQs
 - Danger in developing canned system as human behavior adapts due to consequences and culture
 - Questions on pedigree of information (really enemy disinformation?)
 - Information dependency/overload
 - Defining antecedents of complex human behavior no trivial issue
 - Duplication/overlap of tools
 - Challenge of V&V of complex tools
 - Imputing prescience to tools that are not
 - Failure to accept “lower than attrition – kills” measures
 - Where’s the data? Authoritative Data Sources
 - Lack of a “fast track” approach to adopting in-house H/W and S/W
 - NIH (not invented here) an art form in the analytical world



WG 1 Decision Support for Operations

Focus Question #4 (Recommendations)

- ◆ FIX THE SHORTFALLS
- ◆ Examine/explore access to non-traditional, non-conventional data bases and information
- ◆ Support exercises that are "long enough" in duration to see the effects of analysis techniques
- ◆ Begin understanding DIME + at the tactical level of war
- ◆ Work the problem both top down and bottom up
- ◆ Establish H/W and S/W experiment lab(s) to compare methodologies and tools
- ◆ Build EB COA tools and campaign assessment tools and integrate with IPB and PBA tools
- ◆ Explicitly define EBO, incorporate in Joint doctrine and inculcate in it in Professional Military Education (PME)
- ◆ More study needed on removing the conditions that lead to violent acts
- ◆ Place more emphasis on analyzing Red (and Green) strategy and decision processes and networks
- ◆ Accept less than the "definitive" solution
- ◆ Analysts are people too ... make part and parcel of operations team and focus on recruitment and retention



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BACK UP SLIDES



Types of Effects

- ◆ Effects-Based: *Military* actions, such as operations, targeting or strategy, that are designed to produce distinctive and desired results (Draft definition AFDD 2-1.2)
- ◆ Strategic Effect: Disruption of the enemy's overall strategy, ability, or will to wage war or carry out aggressive activity (AFDD 2-1)
- ◆ Operational Effect: Link between tactical results and strategy; typically the cumulative outcome of missions, engagements and battles. Can also result from the disruption of systems or areas of operational value (AFDD 2-1)
- ◆ Physical Effect (1): The aspects of interdiction - diversion, disruption, delay and destruction - applied to all enemy assets can describe physical effects.
- ◆ Physical Effects(2): Effects created by the direct impact through physical alteration on the object or system targeted by the application of military power



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Types of Effects

- ◆ **Functional Effects:** Direct or indirect effects of an attack or operation on the ability of a target to function properly. In essence, it answers the question, to what extent has the function of the target been degraded or affected by military actions
- ◆ **Psychological Effects:** The results of military action that influence emotions, motives, objective reasoning, and ultimately the behavior of foreign governments, organizations, groups, and individuals (Adapted from the Joint definition of Psychological Operations)
- ◆ **Cascading Effect:** An indirect effect that ripples through an adversary system, often affecting other systems. Typically, a cascading effect flows from higher-to-lower levels of war and is the result of influencing nodes that are critical to multiple adversary systems (Draft definition AFDD 2-1.2)
- ◆ **Cumulative Effect:** The aggregate result of many direct or indirect effects against an adversary. Typically, a cumulative effect flows from lower-to-higher levels of war and occur at the higher levels; however, it may occur at the same level as a contributing lower-order effect (Draft definition AFDD 2-1.2)



Types of Effects

- ◆ Direct Effects: Immediate, first order effects (weapons employment results, etc.) The results of military actions with no intervening effect or mechanism between act and outcome
- ◆ Indirect Effects: Those effects which are created through an intermediate effect or mechanism producing a final outcome or result. They are second or third order effects, which may be functional, systemic or psychological. Indirect effects can be delayed and typically are more difficult to recognize or predict than direct effects.
- ◆ 2nd, 3rd, nth Order Effects: a causes b causes c causes... Disruptions in the electric grid...yield rolling blackouts...which disrupt POL deliveries to airfields...which disrupt air operations.
- ◆ Unintended Effects: Unanticipated, but could impact the campaign or have overall negative consequences. I.E. Destruction of the electric grid shuts down water pumps/water treatment plants, which lead to increased disease levels, ...
- ◆ Reciprocal Effects: Results of your actions have consequences for you that may be unanticipated. Example, destruction of bridge precludes enemy movements — but also affects your ability to move forward



EBO Program Support

- ◆ Several small R&D programs support EBO:
 - DARPA ENDSTATE – advanced coupled infrastructure models; PC platform capabilities; reduced-order physical models; predictive
 - AFRL EBO Program (Rome Lab) – describe program, goals, outcomes of national laboratory programs
 - Other interagency programs (Technical Support Working Group, Dept of Transportation, etc.)
 - Programs are generally not linked to one another, but could benefit from synergies



Current EBO Planning

- ◆ COA Development
 - Formal (WG, simple spreadsheets, if possible model it)
 - Informal (Wag it, chair fly, and hunch)
- ◆ Strategy to Task — very soft measurements
- ◆ Warden's Theories: The five rings
 - Population, fielded forces, infrastructure, key production/energy conversion and leadership
- ◆ Models
- ◆ Home grown tools...spreadsheets

Measurements/Integration are key



MORS Workshop

Analyzing Effects-Based Operations

Working Group 2 Decision Support for Force Structure Planning

29 January 2001 through 31 January 2001
Booz Allen Hamilton, McLean, VA



WG 2 Participants

- ◆ Col John Andrew, AFIT
- ◆ Mr. Jim Bexfield, FS, IDA
- ◆ Mr. John Bolger, SY Technology
- ◆ Capt Shay Capehart, OAS
- ◆ Mr. Don Chappell, Lockheed
- ◆ LtCol Jeff Cohen, JAWP/IDA
- ◆ Col Mike Finnegan, AFSAA
- ◆ Mr. William Gage, GRCI
- ◆ Mr. Rich Hanley, BAH
- ◆ LtCol Max Hanessian, HQ USAF
- ◆ Mr. Gerald Horton, EDO
- ◆ Mr. David Kerr, Sverdrup
- ◆ Mr. Joe Puckett, HQ USAF
- ◆ Dr. Jennifer Rausch, Northrup-Grumman
- ◆ LtCol Robert Reville, AFSAA
- ◆ Dr. Kenneth Robinson, Australian Defense and Technology
- ◆ MAJ John Schotzko, Army G-8
- ◆ LTC Bob Steinrauf, CAA
- ◆ Mr. Peter Stockel, DSTL (UK)
- ◆ Mr. Chuck Werchado, N-81
- ◆ LtCol Kirk Yost, OSD
- ◆ Capt Greg Ehlers, USSTRATCOM
- ◆ Mr. Patrick Curley, GRCI
- ◆ Dr. Ed Smith, Boeing
- ◆ Dr. Jerry Kotchka, FS, Lockheed
- ◆ Dr. Roy Rice, Teledyne-Brown



WG 2 Presenters

- ◆ Effects and the New Defense Strategy (Lt Col Kirk Yost, OSD/Strategy)
- ◆ Issues in Designing Capability-Based Forces (Dr. Dave Markowitz, OSD/PA&E)
- ◆ USAF EBO Concepts of Operation (Lt Col Max Hanessian, AF/XOXX)
- ◆ What the Army Thinks of EBO (LTC Bob Soniak, DAMO-SSP)
- ◆ Navy Perspectives on Force Structure and the New Strategy (Mr. Chuck Werchado, N81)
- ◆ Discussion of EBO Concepts as Applied to Force Structure (Mr. Jim Bexfield, FS, IDA, and Dr. Andy Loerch, GMU)



We considered the problem of the applicable force structure by first covering force structure issues from a variety of viewpoints. The first briefing, from OSD/Strategy, outlines the strategic effects called for in the new defense strategy as described in the 2001 Quadrennial Defense Review (QDR). The second briefing, from OSD (Program Analysis and Evaluation), presents the view that required capabilities are really specified by scenarios. The third briefing centers around the USAF's implementation of EBO thinking in the Air Operations Center (AOC). The fourth briefing (given also in Working Group #1), is an Army doctrinal analysis of EBO. The last formal briefing was given by the Navy, and covers the Navy's issues in trying to build force structure for the new QDR strategy. We concluded the first day by discussing EBO as defined and described elsewhere in the mini-symposium. By the end of the session, we had strategic, budgetary/evaluation, Service, and theoretical viewpoints of "effects."

WG 2 Final Focus Questions

- ◆ For the purposes of discussion, consider 2 cases:
 - (1) Analyses to assess the effectiveness of the current force to achieve near-term effects
 - » Size and shape of the force largely fixed
 - » Decisions are limited to posture and use of force, and operational concepts
 - (2) Analyses that recommend the size and shape of a future force
- ◆ How does emerging EBO theory affect how we do these analyses?



The working group spent considerable time arriving at this final question, which covered the two principal areas of force structure analysis. Most discussions of EBO center around how to achieve effects in a particular situation; there has been much less work on how EBO can help assess the adequacy of a particular force structure, or how it can help design a future force. Consequently, we decided to limit our output to trying to answer this one overarching question.

Effects Demanded by New Defense Strategy

- ◆ The policy ends are:
 - Assure allies and friends
 - Dissuade future military competition
 - Deter threats and coercion against US interests
 - If deterrence fails, decisively defeat any adversary
- ◆ The strategic tenets (means) include:
 - A capabilities-based approach
 - Transformation of the DoD
- ◆ The strategy also includes:
 - Six critical transformation goals (ends for transformation)
 - Four transformation pillars (means for transformation)
 - A force-sizing construct to address decisive defeat



The 2001 QDR report gives strategic effects that are desired in the new strategy. These effects (assurance, dissuasion, deterrence and decisive defeat), are the highest level of “demand” for EBO. In addition, the new strategy also contains certain tenets (which are means to achieve the strategic effects, and are intermediate ends), and other constructs for transformation and force-sizing.

Scenarios, Capabilities and Effects

- ◆ Effects are outcomes or consequences of events/actions (military, political, economic, psychosocial). These can be physical or psychological
 - Example: prevent country A from developing CBRN weapons [defeat (physical) vs dissuade (psychological)]
- ◆ Capabilities are “abilities” to do actions/goals
 - Examples: ability to do persistent ISR anywhere on the globe, 24/7. Ability to move brigade-sized force anywhere on the globe in 96 hours.
- ◆ If the capability is defined with a goal (effect) then there is overlap
 - Example: Ability to halt an invading force in 48 hours
 - » The ‘effect’ is the halt of the force - the outcome
 - » The ability to do so is the capability



One issue confronted by the group immediately was one of sorting out scenarios, capabilities and effects. These are the group's definitions, which we arrived at in order to continue working. One important thing to note is that it is not easy to keep capabilities and effects separated.

Scenarios, Capabilities and Effects (2)

- ◆ Scenario

- A representation of the real world (current or future) "a future, *not* the future"
- Used as the environment in which desired capabilities (specified as goals) can be tested and achievement of those goals can be measured in terms of effects
- Instantiation of socio-political-military goals
- Should encompass the *relevant* socio-political-military environment as context



Most force structure design and assessment is centered around scenarios. One important point of this slide is that a choice of scenarios for force structure analysis is an instance of a nation's overarching policy goals; choosing a scenario that the nation wouldn't react to would be a vacuous analysis. Most of the participants were particularly interested in the U.K.'s approach, which employs 40 scenarios and assesses alternatives with respect to each scenario.

“Little-a” actions, “Little-e” effects, and “Big-E” effects

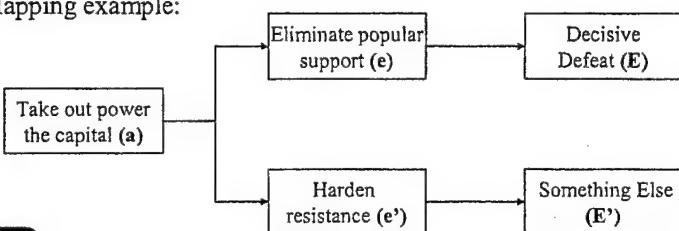
- ◆ Actions (understandable military tasks and operations) are a's
- ◆ e's are the full range of direct and higher-order effects; includes unintended (unknown) effects and unwanted (but known) effects
- ◆ E's are desired strategic effects, frequently behavioral, and can be enduring or situational
- ◆ How do we map from a to e to E?
 - Must include timing, likelihood of success, behavioral aspects, scenarios dependence, unintended and unwanted effects
 - Some workshop speakers have highlighted difficulty of assessing causal relationships (even after the fact)
 - Another speaker did show definable links between a's, e's, and E's



In the plenary sessions, there was a difference of opinion among speakers on our ability to reliably map from actions to small effects to large effects. If we believe in achieving large effects, then clearly there must be a way to move from desired effects (dissuasion, for example) to concrete actions (such as building and fielding an advanced weapons system). One useful construct developed by the group was distinguishing between unintended effects (which are unknown at the time the action is chosen) and unwanted effects (which are known at the time the action is chosen). Clearly, it is very difficult to try to mitigate an unintended effect.

a's, e's, and E's (2)

- ◆ Question: do we have to quantify the entire linkage for
 - Current force structure analyses? (our view is, this is possible)
 - Future force structure analyses? (our view is, probably not possible)
- ◆ So what do we do for future force structure analyses?
 - Map directly from a's to E's, and use many scenarios to make robust choices?
- ◆ Mapping example:



The question debated by the group was whether, for force structure design, it was even necessary to map from a to E. Our conclusion was that it probably was not, particularly if we continue to try to build forces on a capability basis that does not specify future enemies in great detail. Such a mapping could be possible for current force adequacy studies, but it would require considerable study of the enemy.

Analyses to Assess the Current Force

- ◆ Assessment of adequacy of current force structure
 - Risk analysis
 - » Operational risk
 - » Force management risk
 - Generating alternatives for
 - » capabilities to achieve effects
 - » resources to deliver capabilities
 - » postures and rotational policies to achieve effects
 - Games (such as DYNAMIC COMMITMENT) can work
- ◆ These assessments need to be linked to future force structure analysis



In current force structure analyses, desired effects for scenarios are specified in terms of “end states” in the DoD deliberate planning process. These end states are not necessarily effects, as they tend to be in terms of geographical objectives. Furthermore, many of the smaller-scale contingencies the US prosecutes do not involve combat, but are aimed at such things as humanitarian aid or peace stabilization. We concluded that games such as the Joint Staff’s DYNAMIC COMMITMENT series, which considers such events, could help in assessing force adequacy for scenarios requiring a broader range of effects.

Force Content Vs. Force Structure

How to Use EBO to Affect Current Force Structure

- ◆ Munitions
- ◆ Low density/high demand assets
 - ISR
 - Rapid response acquisition and contracting (Hellfire Predator, language specialists)

How to Use the Current Force Structure to Implement EBO

- ◆ C2 (JOC, SJTF HQ)
- ◆ Effects-based planning in J-5's
- ◆ Posture
- ◆ Theater Security Cooperation



Here, EBO is really effects-based thinking

This slide offers some of the groups ideas on how to use effects-thinking in changing the content and structure of the current force. In Operation ENDURING FREEDOM, many effects were achieved by unique combinations of UAV's, precision weapons, and ground forces. Conversely, many organizations in the current force are starting to work in terms of effects for Command and Control (C2), deliberate planning, force posture, and assurance of allies. Such actions are not new, but the notion of trying to subsume these actions into a theory is.

EBO Requires NSC-Level Direction and Deconfliction

- ◆ To plan and execute EBO or to deal with hostile or unintended effects
 - CINC and CINC staffs are not enough
 - Joint Ops Center is insufficient
- ◆ Requires commander's intent from NSC level down
- ◆ Requires *national* level intelligence and expertise for *operational and tactical* level actions



An important observation made by this working group is that achieving effects generally goes well beyond DoD core competencies. Unfortunately, our current command arrangements do not work with organizations that deal in other instruments of national power (diplomacy, economic measures, and so on) until the very highest level of decision making in the US government. It is unlikely that we can avoid unintended or undesired effects at the operational and tactical levels if the intended effects are not communicated and reconciled with other organizations.

Integrating EBO into Future Force Analyses

- ◆ Incorporate into Futures Wargames
- ◆ Effects-Based way of thinking can move us to look at a much broader range of options (an introduction, not a how-to)
- ◆ Must postulate scenarios that:
 - Are driven by vital national interests
 - Identify desired effects
 - Examine different means to achieve effects
 - Identify radical force structure changes that need to occur in light of the desired effects



This slide is largely self-explanatory; if we want to consider effects in future forces, we must specify desired effects for the scenarios and be able to measure progress in achieving those effects. There was no disagreement that doing this will be a tremendous challenge.

Necessary Capability Matrix

Big 'E' Effects

Enduring vital interests

	Assure	Dissuade	Deter	Defeat
US Security				
Security of Allies				
Precluding Hostilities				
Defeating Aggression				
Securing Lines of Communication				

Must Use Scenarios to Generate Desired Capabilities



Finally, this matrix is our initial thinking on a way to develop a “capabilities-based” force. The scenarios must reflect enduring national interests, and we must be able to assess how a particular force alternative achieves the overarching strategic effects. Each scenario must reflect an enduring interest and contain desired effects; each force alternative will have some degree of the necessary capabilities to achieve these effects. All agreed this is radically different from how we do force structure design now.

MORS Workshop

Analyzing Effects-Based Operations

Working Group 3 Wargaming, Experimentation and Exercises

29 January 2001 through 31 January 2001

Booz Allen Hamilton, McLean, VA



Chair: Col Steven Pennington XOCW 703 588 2710

Co-chair: CDR Mike Waldhauser, Naval War College

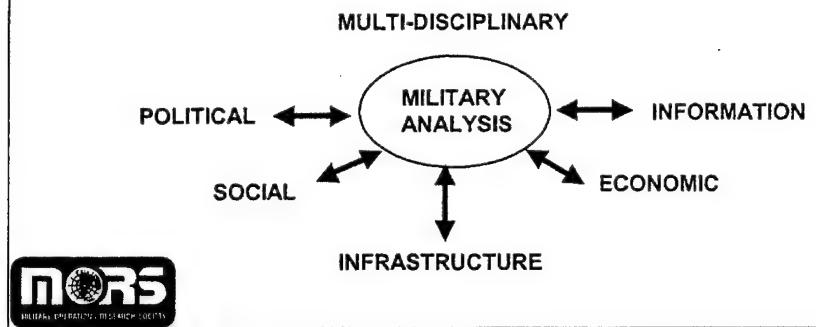
Recorders: Mike Sheen STI 703 588 8889 and Nelson Beard STI 588 2721

Notes on general discussion:

- Initial discussion centered around defining EBO, how it applies to what levels of conflict, and the “fuzzy” nature (social sciences, psychology, and non-military agency involvement).
- To focus the group on requirements for the hotwash, the chairman explained we’re change masters and the real objective, other than exercises, is to figure out what we need to change! Remain at the operational level and look at what we’re going to put out the door by moving from Wargaming to Experimentation, to Exercises. Where are we on the continuum - Wargames - concepts, fuzzy stuff; Experiments - playing with something; Exercises - training - validating concepts and moving into doctrine where it becomes useful to the field.
- In addition, explore the DIME components that contribute to EBO. What do we need to look at to give information back to the Commander. Need both qualitative and quantitative tools and need to figure out what we do well and what needs improvement.

EBO

- ◆ Operational level
 - Definitions: JFCOM
- ◆ CONOPS/Process
 - Quantitative/Qualitative/Multidisciplinary
 - Change required DOTmLpf



- Stay focused at the operational level and use the JFCOM/J9 definition for a working EBO framework.
- Key to implementing EBO is to ensure we have a concept, a process and a CONOPS. To develop CONOPS and processes we need to consider quantitative, qualitative and multi-disciplinary approaches and then determine a strategy to experiment and ascertain what is good and what is bad. Once we know the good and the bad, we can develop a strategy to move from wargames, through experiments, to exercises. This progression should show us what changes to DOTmLpf may be necessary as we approach fielding. DOT and L are capitalized because these areas will probably require the most change and be impacted the most by EBO.
- Our initial thought is that EBO is a multi-disciplinary process requiring both quantitative and qualitative measures as illustrated by the diagram above. As a multi-disciplinary approach, the interactions must be considered two way processes.

WG 3 Wargaming, Experimentation, and Exercises

How are Effects-Based Operations currently analyzed/characterized in wargames, experiments and exercises?

- ◆ Mil v mil domain modeled reasonably well but what about rest of PMESII?
 - Need Multi-disciplinary team
 - Currently M&I ok
 - Explore other existing models
- ◆ EBO process: Planning, assessment, feedback, integration
 - must be a centerpiece of game design and development
 - Currently an add-on
- ◆ Seminar Games?
- ◆ Current focus on destruction – need additional/refocus
 - Integration with other agency games?
 - What about other non destructive applications?
- ◆ Realistic Red
 - Evaluation of perception – Blue/Red; Red/Blue
 - Definition of success?



- We cover the military and force on force domain fairly well. When we move outside of the military domain and consider the relationship of the military within DIME (Diplomatic, Information, Military, Economic) or PMESII (Political, Military, Economic, Social, Infrastructure and Information), we need a multi-disciplinary approach.
- Currently EBO is played as an add on in our wargames and experiments. Smart people trying to impose an EBO framework on games – we're getting better, but need more integration. We need an EBO mindset integrated into the game planning process, framing intent into effects, developing CCIR and ISR plans to produce metrics required to evaluate effects. Then we need tools to assist assessment to evaluate effects and feed them back to players.
- Missing in modeling are pieces that do PMESII well. They rarely optimize at the higher levels (e.g. satisficing argument from plenary presentation). The problem becomes how do you present PMESII to decision makers?
- Synthesis is the fundamental concept for EBO and may lead us to using Seminar Games to address parts and pieces other than the military actions of a game.
- Problem: Wargames compress a long time frame into a short one. Should we restructure because it's hard to capture effects over that short time span? Depends on game objectives.
- Must get into the head of the adversary — must describe the psychology of the enemy leader (also, to play a realistic game, red side must do the same against blue). Leadership description must be included in game descriptors. Also demographics, cultural, economic, societal, and historical considerations. Operational Net Assessment (ONA) will be a key process for both Blue and Red.
- ONA is the tool to inform both blue and red and form the foundation of their plans. We need to do the up front work to change EBO from merely interesting to compelling. Before we make EBO compelling, we need to spend some time thinking about our definition of success.

WG 3 Wargaming, Experimentation, and Exercises

What are the indicators of success for Effects-Based Operations in EEW?

- ◆ Change in adversary behavior
- ◆ How are measures different than real world?
 - Can freeze and examine causes for opponent actions
 - Can observe set of behaviors in more detail
 - Interactions (PMSEII – DIME) alter with different levels of play
 - » Pre-hostilities to onset of hostilities to post-hostilities
 - Emphasis on opponent's plan and perspective
 - Commander's perception of opponent's perspective
- ◆ What are the indicators of effects for EEW Assessment?
 - Add DI&E assessors and players?
 - PMESII interactions
 - Qualitative as well as quantitative
- ◆ Measures to show whether effects are being played
 - Process that realistically evaluates effects
 - Are models being used appropriately



- Must preplan effect MOEs to be successful.
- The shortfall appears to be in measures that show whether effects are being incorporated, planned and played.
- How do you measure this in EEW? M&S capability? Perhaps you start with “did the planning staff consider 2nd/3rd order effects and develop plans accordingly.” Also, is there a mechanism for continuously evaluating effects and providing feedback to decision makers on both intended and unintended effects? Did it work? Was it used?

WG 3 Wargaming, Experimentation and Exercises

What tools and techniques are available to apply to this analysis to measure these indicators of success? What shortfalls exist in this set of tools and techniques?

- ◆ What we've seen
 - Standard analysis tools (Kinetic modeling)
 - TAPS-VSS (decision analysis)
 - CAESAR IIE (Wagenhals/Levis)
 - Influence Nets to Model a Nation-State (Bullock)
 - Leontieff Input/Output model (Capt Snodgrass)
 - BAH Entropy Based Warfare model
 - Expert discussion
- ◆ What's on the horizon
 - Standard Wargaming Toolkit
 - Multi disciplinary/mix of qualitative and quantitative capability
- ◆ What we'd like to see
 - Need models of non-destructive processes
 - Use of warfighting decision tools in wargaming
 - Tools to look at decision processes
 - Models that produce output as "plausible distributions"



- Several models and tools in various stages of development and some have been used in wargames, but with varying success and acceptance.
- Lack of standard definitions, CONOPS, and understanding of the process hamper implementation.
- EBO process is not ready to be played in exercises, but we're attempting to explore it in wargames and moving into experiments.
- Introduction of the Standard Wargaming Toolkit will provide a forum for presenting and evaluating tools for better integrating and representing EBO. These too must include a mixture of quantitative and qualitative tools representing a multi-disciplinary approach.
- Models of non-destructive events (maneuver, IW, diplomatic or economic factors) will be required for the multi-disciplinary approach.
- Integrating developing decision support tools for real word command centers into wargaming and experimentation events.
- Decision process tools and models that produce ranges of solutions rather than point solutions would be conducive to giving leaders a range of options.

WG 3 Wargaming, Experimentation, and Exercises

What recommendations do you have to improve the existing Effects-Based Analysis capability?

- ◆ Near Term
 - Process
 - » Definition
 - » Lexicon
 - » Measures
 - Then you can build right analytic components
- ◆ Long Range
 - Capture ambiguities
 - Develop capabilities to analyze these for traceability
- ◆ DOTmLpf
 - Capstone Joint Doctrine
 - » Joint Effects Board
 - Blue's Red Cell on Commander's staff
 - » JTF / SJFHQ organization and process
 - Educate and Train to EBO thought processes
 - Leadership development
 - » Exercises
 - » Senior mentors



- Near term solutions are in the areas under discussion at JFCOM — definitions, lexicon and measures. You can't build the analytic components and have them accepted in the community without common, understood definitions; a common and accepted lexicon; and understood and accepted measures.
- Long term solutions need to be able to capture the ambiguities of effects (multiple actions producing a single effect as well as multiple effects being produced by a single action. Additionally, the same action may produce conflicting and contradictory effects) and to analyze the causal links by tracing effects back to actions.
- Major process improvements probably lie in doctrine, organization, training and in developing leaders with an EBO mindset. Leader development will depend on moving the concept from wargaming and experiments in to exercises. If they don't see it, they won't use it.

MORS Workshop

Analyzing Effects-Based Operations

Working Group 4 Indicators of Success

29 January 2001 through 31 January 2001
Booz Allen Hamilton, McLean, VA



WG 4: Indicators of Success

WG 4 Team Members

- ◆ Gary Wheatley—Chair (EBR)
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- ◆ David Ball (DS&T Lab)
- ◆ Mary Bonnet (AFSAA)
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- ◆ Charles Heatley (Defense Group Inc.)
- ◆ Michael Horn (Boeing)
- ◆ Major Fernando Huerta (USAFAS)
- ◆ Tom Johnson (IITRI)
- ◆ Bill Kaiser (CJ3 USFK/8th Army)
- ◆ Graham Kessler (JFCOM)
- ◆ Robert LaFollette (JWAC)
- ◆ Graham Mathieson (DSTL)
- ◆ Adrienne J. Murphy (JAWP/IDA)
- ◆ Telyvin Murphy (EBR)
- ◆ Richard Null (Lockheed Martin)
- ◆ Geraldine Rogers (BAH)
- ◆ Major Thomas Sloan (AFSAA)
- ◆ Carl Stephens (SPA)
- ◆ Major George Tadda (AFRL)
- ◆ Lt Col Michael Butler (USAF)
- ◆ Capt Anthony Snodgrass (AFOTEC)
- ◆ Mark Fiebrandt (JFCOM)



WG 4: Indicators of Success

Focus Questions

- ◆ What are the indicators of success for analyzing Effects-Based Operations?
- ◆ How are these indicators of success different from the traditional measures of merit for Attrition-Based Operations?
- ◆ What tools and techniques are available to measure these indicators of success? What shortfalls exist in this set of tools and techniques?
- ◆ What recommendations do you have to improve the existing Effects-Based Analysis capability?



These focus questions were provided by workshop leaders. After we worked on question 1 for a couple hours we realized that we needed to answer question 2 first. Once we determined what was different about EBO indicators (as opposed to attrition) we were able to proceed.

WG 4 Indicators of Success: What's Different

Assuming:

- Effects are created by taking actions
- Desired effects change states on a path/trajectory to the desired endstate (e.g. stepping stones)
- One action may create more than one effect (states are multi-dimensional)
- Other active agents are influencing state changes
 - » more than one system is included at each state (e.g. political and social)
- System is complex (not adaptive yet)

Then, indicators of success for EBO:

- Must show validity of the effect/state
 - » Display progress along causal path of transition to next desired state
 - ◆ Are our actions producing our desired effects?
 - » Display movement toward other states (undesired, etc)
 - ◆ Are our actions producing other effects?
 - » Display realities of many dimensions (e.g. P state AND S state)
 - ◆ Did our actions influence more than one system?



The “what’s different” analysis proceeded through two steps. First we looked a complex but non-adaptive system and described the characteristics of Indicators of Success (IOS) as shown in the slide.

WG 4 Indicators of Success: What's Different

Indicators (continued):

- Must show validity of the path/trajectory
 - » Are the stepping stones actually leading us to the desired endstate?
- Indicators will have more dimensions than the actions taken
 - » Action may be taken against P system, while indicators will need to show change in both P and S systems because P and S systems interact (change in S system may be direct, indirect or unrelated to your actions)

Then in a complex adaptive system:

- Indicators will have temporal validity (might only be relevant for a short period of time) as the state transition network may/will change over time
 - » Trajectories to reach the desired endstate may change



In EBO there appear to be no simple cause-effect relationships. Actions taken in one domain can produce changes in other domains and also cause changes that are unrelated or unintended in all domains.

In a complex adaptive system the temporal dimension is added. The transition through states may change over time and the desired end state also may change as we observe the adaptation of the adversary to our actions.

WG 4 Indicators of Success Scenario

Commanders estimate and intent:

- The islands A, B and C sit astride a strategic waterway. Although these belong to country Green, they have been illegally occupied by Red
- Red has threatened to close the strait

JTF Task objectives:

1. Return control of islands to Green
2. Maintain freedom of navigation in region
3. Prevent use of WMD



Discussions throughout the Working Group seminars led us to the conclusion that indicators are scenario specific. As a tool to generate indicators of success, a generic scenario was created. In this case, country Red occupied a series of islands belonging to country Green. Green is an ally of the US and it is in the best interest of the US to re-establish Green control over these islands. A JTF has been formed and specific missions issued from the NCA.

WG 4 – JTF Considerations

- ◆ **JTF Specific**

- Minimize collateral damage on islands and impact on world economy
- No first direct attack on Red homeland
- Green forces/facilities are available
- Blue forces normally in theater as well as additional ISR assets are available
- Time is not a limitation

- ◆ **Intra-Department Assistance Required**

- UN/OPEC support to keep commerce (e.g. oil) flowing
- Warning (direct/indirect) to Red not to use WMD
- Overflight rights/port access
- Restrain other threats in theater
- Pressure on Red through country Orange



The JTF must operate under certain considerations. Here are samples of some of the considerations (and in some cases, restrictions) under which the JTF must operate. The JTF will also require outside agencies to provide assistance.

WG 4 – JTF Concept of Operation

Three Phase Operation

♦ Phase I (Information Operations):

- Reduce Red public support for seizure
- Control C3 between island & Red homeland
- Shape world support for Blue operations
- Emphasize Red threat to regional economy
- Blue will stay as long as necessary
- Focus ISR on WMD, Red force status, mines

♦ Phase II (Isolation of Islands):

- Minimize impact on commercial traffic through straits
- Exclude Red forces from straits
- Deny Red military access to islands
 - » Maximize use of Green/other Allied forces



The JTF Commander's concept of the operation is in three phases (information operations, isolation of the islands and resolution). Later, indicators will be developed to measure success or failure.

WG 4 – JTF Concept of Operation (cont.)

◆ **Phase III (Resolution):**

- Convince Red to leave islands
- Threaten/rehearse island assaults (show of force)
- If Red does NOT leave islands, conduct forced entry operations
- Be prepared to strike WMD sites



WG 4 - Scenario Strategic Considerations

Political objectives:

1. Avoid restrictions on Freedom of Navigation (FON) (economic threat)
2. Be seen to uphold international law (support World Court decisions)
 - Political/social pressure to maintain rule of law
 - National Command Authority (NCA) wants to be seen "doing good"
3. Avoid use of WMD
 - Red must not feel so threatened that they need to use WMD
 - But we might want to threaten Red with reprisal as a deterrent
 - Influence by regional neighbors important in this
4. Promote longer term stability in region
 - Shouldn't leave Red feeling too unhappy at the end.

Info Campaign messages:

- ◆ We will not tolerate closure of international waterways
- ◆ We support the World Court
- ◆ We will not tolerate use of WMD



The four political objectives (invented for the purposes of the scenario) show a typical spread of short and long term thinking and the tricky balancing act needed to obtain longer term disaster avoidance. Example, we want to threaten Red to deter them but not so much that they lash out in unacceptable ways (i.e., WMD) or are left as victims seeking later revenge.

The main messages for the Information Campaign are an important impact area for unintended effects of other activities.

WG 4 - Scenario Political Indicators

Failure indicators

- ◆ Red feels very threatened
 - Aggressive rhetoric
 - Preparations for response (WMD?)
 - Force build-up on mainland
- ◆ Oil prices rise
- ◆ FON is inhibited
- ◆ Red builds up military in islands
- ◆ Red builds up military support on mainland
- ◆ Regional media rhetoric

Success indicators

- ◆ No combat in region
- ◆ Red feels deterred
 - Aggressive rhetoric
 - Submissive rhetoric
 - Withdrawal of preparations
- ◆ Orange influencing red favorably
- ◆ FON maintained
- ◆ Red military forces reduce
- ◆ Regional media support
- ◆ Logistic support from other nations in region
- ◆ Favorable UN resolutions
- ◆ International media support
- ◆ Wider political/military support

Ambiguous



Do any of these indicators support the political objective to promote long term regional stability? Favorable UN resolution, logistic support from regional neighbors and wider political/military support lead to shorter term stability but are not clear indicators of longer terms stability.

US use of power to restore status quo sends message that US will continue to do so and may work towards longer term stability (or might just make people more upset with the US).

Military activities are mainly about short term objective achievement, so what can military do to leave the field in a good state for diplomatic/political management of longer term situation?

In limited conflicts the military objectives are dynamically subservient to diplomatic/political objective, so sub-optimized military activity may be needed to allow other dimensions to operate effectively. Thinking through the effects may allow a more refined military strategy which services the political effects objective but minimizes the sub-optimization of the military effort.

WG4 - Operational Indicators

Failure indicators

- ◆ Potential preparation of WMD assets
 - Could be protection measures
- ◆ Red force staging/mobilization
 - Preparing for escalation
- ◆ Blue force negative interactions with media
- ◆ Red deploys mines or other FON countermeasures
- ◆ Red military traffic gets through to islands

Success indicators

- ◆ support by regional nations (e.g. ports/overflight rights)
- ◆ Red force staging/mobilization
 - Response to successful threat
- ◆ Blue control of communication traffic to islands
 - Communication traffic on known links
 - Interdiction capability
 - But interrupting C3 inhibits effects of successful deterrence
- ◆ Blue force positive interactions with media
- ◆ More Green/other forces in coalition
- ◆ Red military not trying to get to islands





Do operational indicators correctly indicate we are on the path to political success?

Potential preparation of WMD assets is seen as an operational failure and is on the route to political failure.

Red force mobilization and staging could be an operational indicator of failure that links with political failure (Red feeling very threatened). However, Red force mobilization could also be seen as an operational indicator that Red feels mildly threatened which might be consistent with the political success objective of deterrence. So the operational indicator is ambiguous at the political level.

Also, the operational success indicator that more Green/other forces are actively involved might be seen as contributing Red feelings of being under great threat, which indicates a political failure.

Similarly, Red not trying to get to island (an operational success indicator) is consistent with Red re-grouping in a mainland build-up, which is a political failure indicator.

Other positive and negative connections can be drawn to show how the military operational success and failure indicators are consistent (or not) with the political indicators.

This analysis would be useful in forming part of the inter-agency synchronization needed during management of planning and operations.

POLITICAL FAILURE

- ◆ Red feels very threatened (aggressive rhetoric, preparations for response)
- ◆ Red builds up military in islands
- ◆ Red builds up military support on mainland
- ◆ Oil prices rise
- ◆ FON is inhibited
- ◆ Regional media rhetoric

POLITICAL SUCCESS

- ◆ No combat in region
- ◆ Wider political/military support
- ◆ Red feels deterred (aggressive/submissive rhetoric, withdrawal)
- ◆ Orange influencing red favorably
- ◆ FON maintained
- ◆ Red military forces reduce
- ◆ Regional media support
- ◆ Logistic support from other nations in region
- ◆ Favorable UN resolutions
- ◆ International media support

POLITICAL OBJECTIVES

- ◆ Avoid restrictions on freedom of navigation (economic threat)
- ◆ Be seen to uphold international law
- ◆ Avoid use of WMD
- ◆ Promote longer term stability in region

INFO. CAMPAIGN MESSAGES

- ◆ We will not tolerate closure of international waterways
- ◆ We support the World Court
- ◆ We will not tolerate use of WMD



No work was done to review political indicators and political objectives to see if there were any potential counter-indicators or ambiguities, but this would be useful and should be part of any EBO analysis.

WG4 Analytical Tools for IOS

- ◆ Influence Models
- ◆ Intelligence Fusion Tools
- ◆ Data Mining, Automation and Queuing Tools
- ◆ Collaboration Tools
- ◆ Behavioral Models



To improve the state of the analysis of EBO, WG 4 came up with five analytical techniques that we thought would be beneficial for practitioners and for decision makers. Influence models are currently being used by many defense and non-defense entities with some success. WG 4 believes their use should be expanded and the temporal aspect added to make them more useful.

Intelligence fusion tools may prove their worth by taking data from a myriad of sources and putting information together to aid the decision maker in checking for his positive and negative indicators of success. Data mining, automation and queuing tools will help bring the wealth of data already available or being collected together to enable analysts and decision makers to look for and anticipate changes in success indicators. Collaboration tools (along with the collaboration of individuals) will help bridge language and communications gaps between different communities — such as NGOs, State Department, and DoD — involved in trying to bring about political effects as well as operational effects. Behavior models are not in the usual arsenal of military operations research analysts and should be included in EBO to foster understanding of complex adaptive actors.

WG 4 Indicators of Success: Conclusions

- ◆ Less direct cause and effect relationships in EBO than in attrition based operations
- ◆ Indicators of success tend to be scenario specific
- ◆ There is never a final end state but indicators should show progress towards some intermediate end state
- ◆ Equivalent of BDA in EBO is monitoring the situation



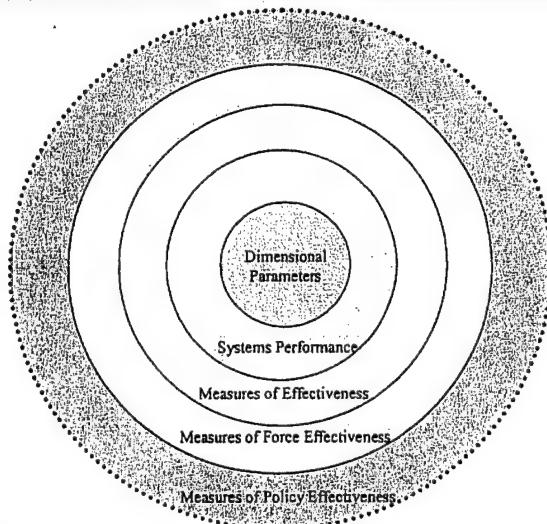
Measurement in EBO is vastly more complicated than measuring operational effectiveness in one dimension. There are more cause and effect relationships but fewer specified direct cause and effect passageways in EBO. Part of the reason for this phenomenon is our limited understanding of EBO, that contributes to a lack of hypotheses for us to test and examine to check for cause and effect. EBO is inherently scenario specific and, for analysis, must be cast inside an operation with specific goals and objectives. Due to the difficulty in specifying the effects of a final end-state, indicators focused on operational effects should be based on the commander's intent and stated objectives. Indicators leading to transitional end-states are more useful in an operational context and should show progress towards that intermediate end-state. Since effects are not always in the military arena, and since decision makers may (due to political or other pressures) change their goals, it is essential for EBO analysts to be able to measure effects by monitoring, evaluating and sorting through situational data as the operation progresses, to see what is happening and how it is different than what has previously happened — in order to judge the effects on the operation.

WG 4

Back up Slides



Measures of Merit Conceptual Relationships



WG 4: The Continuum of Conflict

- ◆ Influence/Shape
 - ◆ Deter
 - ◆ Coerce
 - Persuade
 - Threaten
 - Demonstrate Capability
 - Disable Adversary Capability
 - Defeat Adversary
 - Punish
 - ◆ Compel
 - ◆ Defeat
 - ◆ Transition
- ◆ Compel/Defeat actions are Coercive
 - ◆ To be successful Coercion must have an Adversary who:
 - Knows what is wanted
 - Has the ability to do what is wanted
 - Has some value threatened
 - Perceives coercive threat as more negative than value of behavior
 - Perceives threat to be creditable
 - Believes we are willing to do it



WG 4 Indicators of Success: Political

- ◆ Example of desired political effect: Change the behavior of a political leader
 - Leader's actions indicate compliance with our desired behavior
 - Statement(s) of leader and other political leadership
 - Actions of population (e.g., demonstrations/riots)
 - Actions/Statements of neighboring nations



WG 4: The DIME/PMESII Matrix

	Political	Military	Economic	Social	Infrastructure	Information
Diplomatic	G	Y	Y	X	Y	Y
Information	G	G	G	G	G	G
Military	G	G	G	Y	G	Y
Economic	Y	Y	G	Y	Y	Y



DIME – Diplomatic, Information, Military, Economic

PMESII – Political, Military, Economic, Social, Infrastructure and Information

WG 4: Indicators of Success: General (DIME)

- ◆ Diplomacy should lead. It should orchestrate the I., M, E
- ◆ Information is a strong tool to produce effects across the entire PMES realm
- ◆ Military action can have a strong effect on political and military sectors
- ◆ Military action can disrupt economy sectors
- ◆ Military action will likely have little social impact
- ◆ Economic action will likely have long term effect(s) versus immediate observable impact



WG 4: Indicators of Success: Political

Example: Change behavior of a political leader

Effects Based Indicators: Require a strategy and desired end state

Credibility depends on evidence of behavior change and truthfulness of leader

Movement towards changed behavior are transition states which are intermediate measures to get to desired end



- Governmental actions towards desired behavior
- Statements by the leader
- Statements by other Political leaders
- Statements and actions are consistent
- Change of leadership
- Popular support (e.g., demonstrations/riots)
- Military support (e.g., coup attempt)
- Actions of Regional Allies and Neighbors

WG 4: Indicators of Success: Military

- ◆ Example of desired effect: Neutralize adversary military effectiveness
 - Adversary readiness/degree of mobilization
 - Adversary military activity
 - Adversary Aggressiveness
 - Desertion numbers/rate
 - Casualties
 - POWs captured



WG 4: Indicators of Success: Economic

- ◆ Example of desired effect: Reduce adversary's ability to purchase arms:
 - Economic indicators (e.g., inflation, foreign debt)
 - Prices (e.g., food, fuel)
 - Taxes
 - Foreign investment: Amount, by whom
 - Availability of goods and services



WG 4: Indicators of Success: Social

- ◆ Mobility of the population
- ◆ Phone/communications use
- ◆ Social stability
- ◆ Relative freedom of the media
- ◆ Public health



WG 4: Indicators of Success: Infrastructure

- ◆ Amount of infrastructure services available: Roads, railroads, communications, media,
- ◆ Status of repair(s)
- ◆ Volume of usage



WG 4: Indicators of Success: Information

- ◆ Degree of government control
- ◆ Volume
- ◆ Path (e.g., direct to population)
- ◆ Degree of hostile activity



WG 4: Indicators of Success: Other Considerations

- ◆ Effects-Based Operations must be carefully orchestrated and coordinated, otherwise an action in one realm might have a negative impact in some other realm
- ◆ Need to determine and assess 2nd and 3rd order effects and their Indicators of Success (which may be different from those of 1st order effects)



MORS Workshop

Analyzing Effects-Based Operations

Working Group 5 Fundamental Sciences

29 January 2001 through 31 January 2001

Booz Allen Hamilton, McLean, VA



This is the presentation of Working Group 5, focused on addressing the fundamental sciences that can and should be brought to bear on the problem of analyzing effects-based operations. As will be seen, this involves bringing together a wide variety of disciplines.

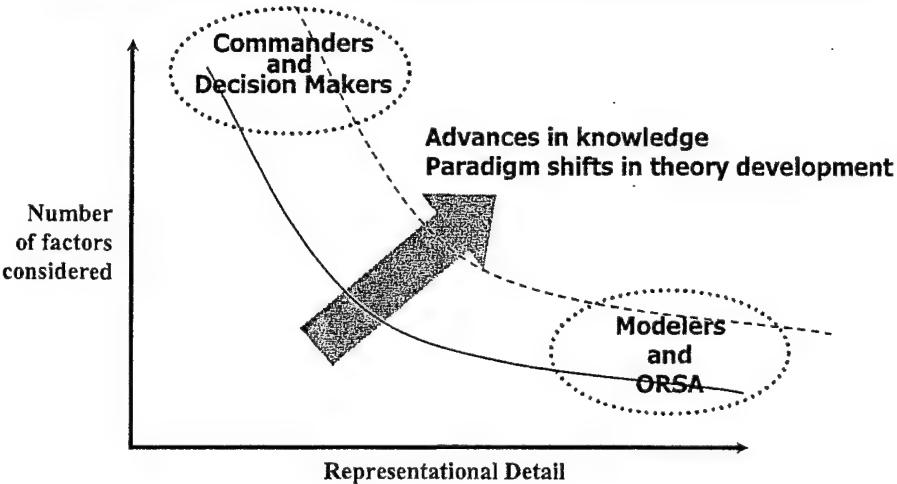
Participants

- ◆ LtCol Steve Rinaldi, AF/XPQI (Chair)
- ◆ Jeff Cares, Alidade Consulting (Co-chair)
- ◆ Alan Zimm, JHU/APL
- ◆ Dr. Stephen Biddle, USAWC
- ◆ Dr. Dennis Leedom, EBR Inc.
- ◆ Dr. Marco Fiorello, SYS
- ◆ George Brander, DSTL-UK
- ◆ Mr. Frank Mahncke, JWAC
- ◆ Mr. Richard Bird, AF/CVX
- ◆ Dr. Mike Senglaub, Sandia National Laboratory
- ◆ Mr. Gerald Boxer, BAH, Inc.
- ◆ Mr. John Byrnes, AFRL/XPZ
- ◆ Dr. Dez Saunders-Newton, NDU



Shown here are the participants. In all, the working group represented a wide variety of academic and operational perspectives.

Analytic Challenge



The nature of the analytic challenge is shown here in a diagram that compares two factors: (1) the number of factors considered in the analysis or modeling effort; and, (2) the level of representational detail for each of those factors. The availability of theory, data and computational resources typically leads to a tradeoff between these two aspects of analysis.

The issue faced in this workshop is how we begin to move from the present state of modeling (shown in the lower right corner) to the needs and interests of the end-user: the CINC or operational commander. Our goal of this workshop is to define a strategy for how we push this tradeoff curve to the upper right through advances in knowledge and refinement of our theoretical paradigms for addressing effects-based operation.

WG 5 Fundamental Sciences

Focus Questions

1. What are the areas of fundamental sciences that are most useful in analyzing Effects-Based Operations?
2. What tools and techniques based on these sciences are available to apply to measure the indicators of success? What shortfalls exist in this set of tools and techniques?
3. What recommendations do you have for further research in fundamental sciences as the basis for improving Effects-Based Analysis capability?



The working group was given three basic questions to address.

Fundamental Sciences

	PHYSICAL	INFO	COGNITIVE	SOCIAL
Linear, Multivariate Analysis	X	X	X	X
Philosophy/Epistemology		X	X	X
Network Analysis		X		X
Control Theory	X	X		
Human Decision Making		X	X	X
Organizational/Mgmt Science		X	X	X
Economics	X		X	X
Political Science			X	X
Information Science	X	X	X	
Complex Adaptive Systems	X	X	X	X
Evolutionary Computation	X	X	X	X
Problem Space Analysis	X	X	X	X
Physical-Cognitive-Social Integration	X	X	X	X
Field-based Investigation	X	X	X	X
Qualitative Modeling and Discovery			X	X
Multiscale Representations	X	X		X



In response to the first question, the working group identified a number of fundamental sciences or methodological areas that potentially contribute to our understanding and analysis of effects-based operations. These fundamental sciences and methodological areas were then mapped into the four basic domains that must be addressed in the analysis of effects-based operations. These same domains will be used in a later slide to assess the level of maturity of our science in each area.

Tools

- ◆ Agent-based models, theory of emergence
- ◆ Dynamics and networks analysis
 - Social networks, influence nets, etc.
 - Network archetypes
- ◆ Formal logics, validation of data
 - Validation/verification
 - Rational constructs, cultural context
 - Theory-driven data collection
- ◆ Theory development vs. tool development
 - Interdisciplinary contributions
- ◆ Ways to trace resource allocation to effects
- ◆ State space/control representations
 - Expert surrogates, limitation of adversary options, models of enemy, requisite variety, modes of failure



The working group also spent several hours identifying specific tools and methodologies that — if advanced — would assist the ORSA community in the development of an effects-based operations “tool kit” for either the CINC/operator or the force development analyst.

Tools

- ◆ iThink/Stella/Dynamo, Systems Dynamics
- ◆ Network analysis tools that unveil the hidden structure
- ◆ Evolutionary modeling with back-propagation
- ◆ Computational experimentation
- ◆ Visualization
- ◆ Applied simulation science
- ◆ Co-evolutionary wargaming

Caveat: This list is the product of 10 people in a room on Wednesday!



Shown here are additional tools considered by the working group.

The major caveat to add to this list is that it was the product of 10 people in a room on Wednesday. Given more time and the addition of other technical representatives, we feel that this list would grow. This issue will be addressed in our recommendations slide.

State-of-Art (vis-à-vis EBO)

	Physical (Linear)	Physical (Non- Linear)	Information	Cognitive	Social (Org)	Social (Society)	Integration
Problem Definition	10 green	6 yellow	4 red	6 green	9 green	8 green	4 red
Constructs/ Metrics	10 green	6 yellow	6 yellow	4 red	5 yellow	7 Yellow	4 yellow
Theory	10 green	2 red	3 red	4 red	3 red	4 red	2 red
Analytical Tools	10 green	2 red	2 red	2 red	2 red	2 red	1 red
Analyst/User Involvement	2 red	1 red	5 yellow	2 red	2 red	1 red	1 red



To provide a roadmap for the future, the working group developed an assessment of the state-of-art vis-à-vis the application of different sciences to the problem of analyzing effects-based operations. Each area of representation is assessed in terms of its level of maturity in: (1) defining the basic problems to be addressed; (2) the development of relevant and valid constructs and metrics for empirical measurement; (3) the development and refinement of causal theories; (4) the translation of these causal theories into analytic tools and models; and, (5) the overall level of interaction and involvement of the ORSA community with the end-user.

Each area was assessed on a 10-point scale, with 10 being fully mature, 1 being of little maturity, and numbers in between reflecting different states of moving from a pre-paradigmatic science to a normal or mature science. The colors reflect the general band that each assessment falls into.

As suggested by this chart, those areas in red require the most attention and investment.

Recommendations

- ◆ Establish an office of responsibility for institutionalizing research and analysis on Effects-Based Operations
 - Promote interdisciplinary research approach (with selective project funding)
 - Integration of theories, databases, models as they apply to EBO context
 - Publish/promulgate state-of-practice advances to analytic community and stakeholders
 - Link inter-agency community (e.g., State, Intelligence, Treasury, Justice, FEMA) and coalition partners
- ◆ Promote field deployment/assignment of ORSA practitioners to the field
 - First-hand involvement in defining the problem and crafting the analytic response
 - Promote analyst/end-user dialog and development of ideas
- ◆ Promote bottom-up development and refinement of analytic toolkit
 - Broaden the community of participants in model/tool development
 - Field-based prototype-test-prototype cycle to inform theory development



Finally, the working group arrived at a prioritized set of three recommendations. These recommendations are best understood by starting at the bottom and working upwards.

Our third recommendation reflects the view that a mature theory of effects-based operations will evolve in a bottom-up fashion as practitioners and users define useful prototype tools and models to assist them in addressing real-world EBO tradeoffs. Much, if not most of this work ought to be done in an applied context with full user involvement.

The second recommendation facilitates the third by arguing for increased deployment and assignment of ORSA practitioners to the field where they can become involved first-hand in the operational problem. This recommendation seeks ways in which the MORS Sponsors, working with the CINCs, can identify ways of promoting the analyst/end-user dialog and development of creative approaches to EBO analysis, planning and execution.

Finally, the first recommendation recognizes the benefits that would accrue by institutionalizing this research at a senior level within DoD. Following the model illustrated by OSD's Command and Control Research Program (CCRP), a central office of responsibility could be established to oversee and facilitate: (1) the promotion of interdisciplinary research; (2) the integration of theory with empirical evidence; (3) the promotion and dissemination of scientific advances to the analytic community and set of stakeholders; and, (4) establishing and maintaining key linkages to other federal and coalition partners in this area.

MORS Workshop

Analyzing Effects-Based Operations

Working Group 6

Effects Based Analysis of Counter Terrorism

29 January 2001 through 31 January 2001

Booz Allen Hamilton, McLean, VA



-
- ◆ Chair: Mr. Randy Pherson
 - ◆ Co-Chair: Lt Col Eileen Bjorkman
 - ◆ Advisor: Dr. Bob Sheldon



Working Group Members

- ◆ Edward Emond (National Defense Canada)
- ◆ David Rolston (Joint Warfighters JT&E/Joint Battle Damage Assessment JT&E)
- ◆ Tom Allen (IDA)
- ◆ Eileen Bjorkman (DMSO)
- ◆ Bob Sheldon (Emergent)
- ◆ Stephen Hood (Embassy of Australia/DSTO)
- ◆ Maj. Ruben Bell (USAFE Warrior Preparation Center)
- ◆ David Botto (JHU/APL)
- ◆ Duane Boniface (JHU/APL)
- ◆ Gary Horne (MITRE)
- ◆ E.P. Visco, FS (self)
- ◆ Mike Haxton (JWAC)
- ◆ Clifford Krieger (DRC)
- ◆ Randy Pherson (EBR)
- ◆ Ed Kruzins (Defense Science and Technology Organization, Aus.)



A very productive group that should be commended for their insights, creativity, and active engagement in the process. Our approach was two fold:

1. Define the analytical space from the optic of EBO
2. Identify the most appropriate analytic tools and areas where new tools may be needed.

Definitions of Terrorism

- ◆ DoS: premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine agents, usually intended to influence an audience.
- ◆ WG 6: The politically motivated and planned use of violence against society by groups, networks or organizations that possess the will and capability to inflict substantial harm outside their immediate environment (both physically and electronically).
- ◆ President Bush (9/20/01): “Our war on terror. . .will not end until every terrorist group of global reach has been found, stopped and defeated.”



Although in the first meeting of the working group there was some discussion of not using the word terrorist because of the emotional baggage attached to it, no suitable alternative was suggested. After some presentations and discussion we came upon a definition of terrorism that we were comfortable with. It is important to note that there are several different definitions being used by the US Government at this time.

The US State Department (DoS) has the one cited above, The CIA web site refers you to Title 22 of the US Code, Section 2656(f), which states:

- 1) The term “international terrorism” means terrorism involving the territory or the citizens of more than one country.
- 2) The term “terrorism” means premeditated, politically motivated violence perpetrated against noncombatant targets by subnational groups or clandestine agents, usually intended to influence an audience.
- 3) The term “terrorist group” means any group that practices, or has significant subgroups that practice, international terrorism.

From an EBO perspective three critical dimensions worthy of explanation were:

- 1) Whether the phrase “intended to influence an audience” is too restrictive and should be expanded to read “to inflict substantial harm”
- 2) The need to include will and capability in the definition.
- 3) The fact that in today’s world terrorist groups increasingly have global reach.

This war on terrorism is unlike many in the past because the enemy is so ill defined. It was pointed out in the group, however, that the war on terrorism has an enemy similar to that of the war on drugs.

Question 1

◆ How is effects based analysis currently used?

- Terrorism by its methods is an effects based operation
- Due to the needs of countering terrorism, including that it must be addressed by multiple agencies concurrently, counter terrorism itself must be an effects based operation

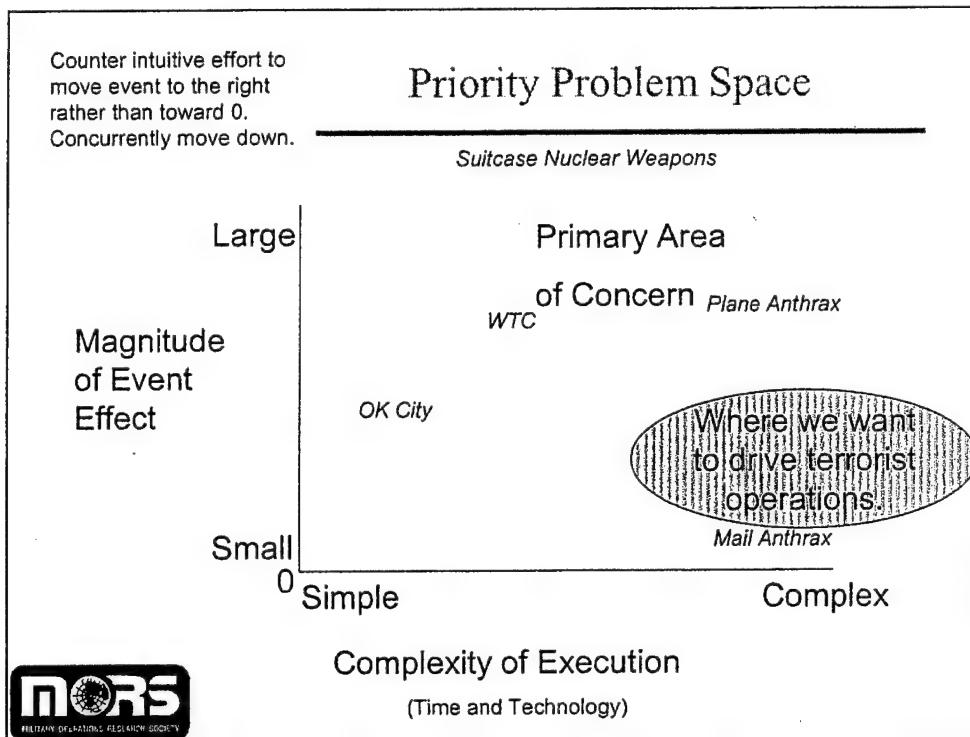


Although the military may not have always been focused on effects based operations, the terrorists have. Terrorist groups have always operated with several concurrent goals, those include:

- infamy - given by media coverage, and the drastic nature of their actions, those actions physical results; and,
- psychological impacts on the target audience.

While the attacks on September 11 had a greater human toll, the anthrax scare afterwards may have had a greater psychological effect on the nation as a whole. While people in Ohio may have been horrified by what they saw on the television, they were probably not scared of being a target themselves, where sending anthrax through the mail certainly scared a large number of the population.

Given that the threats/targets of terrorism are widespread, it is virtually impossible to think of hardening all possible targets. Likewise, it is impossible to think that the military will be the sole protector against such threats. All government agencies involved — Department of Justice, Department of State, Department of Defense, the Intelligence Community, Department of Commerce — must cooperate to work the problem.



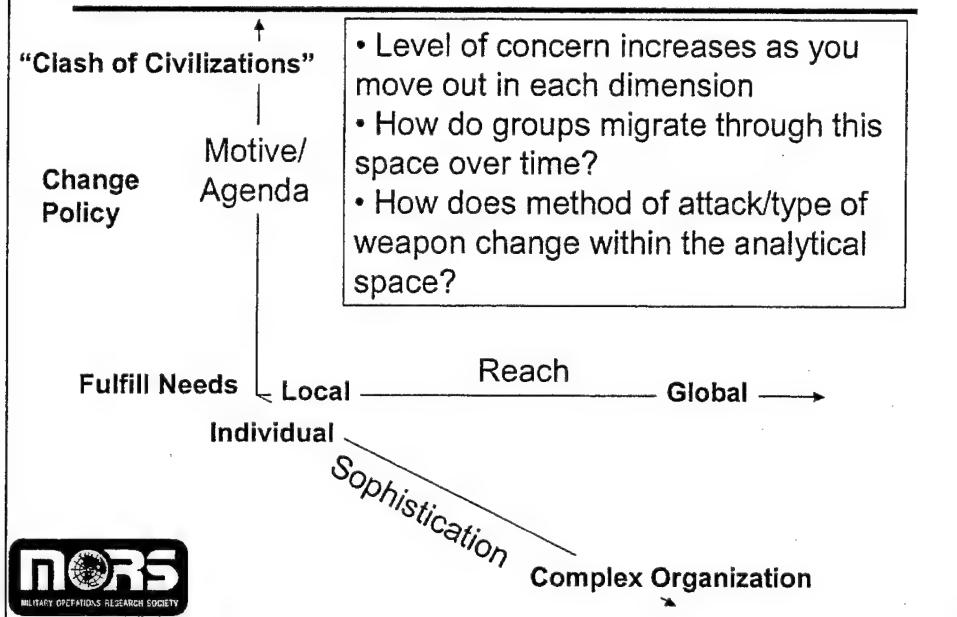
This graphic is meant to identify the problem space of terrorism. The upper right quadrant represents the primary area of concern where complex operations result in large numbers of casualties.

At first it was assumed that you want to drive terrorists to operate in the lower left-hand quadrant. However, after a bit of discussion the group decided that that is really where Israel is currently, and that is not a desirable state for the country as a whole. We would rather drive terrorist activities to the lower right quadrant because they would take longer to orchestrate, could be detected easier, and are more susceptible to analysis.

This slide addresses the fact that in order to prevent terrorist acts an EBO approach is needed. As you move from left to right, indicators can be developed to anticipate and prevent terrorist acts. Although you would like to destroy all groups, containment is a more realistic objective. Moving to the right and down gives you more time to analyze and to prevent.

There is also the idea that disinformation about the US's ability to protect itself from certain threats may be used to drive terrorist activities into the lower right hand quadrant.

Critical Dimensions of the Problem



Terrorist groups often have one specialty, be it bombing, assassination, or other activity. They also often have one cause. However, when a group gets as large as Al-Qaeda, their motives move up that axis as their reach and sophistication expand simultaneously.

Each axis on this graph can be defined as follows:

Reach:

Local, sub-national (GAM (Aceh), semi-insurgency groups, like FARC)

National (IRA, PLO, Basques)

Regional (Hizbollah)

Global (Al Qaeda)

Motive/Agenda

* "Fulfill Needs" (release prisoners, pay ransom)

* Global Agendas (change of civilization)

* Change Government Policy (ELF, Jerusalem's Status)

* Nihilist (where do they fit on this scale)

Sophistication

* Individual

* Small Group

* Structured Organization

* Complex Organization

* State

One problem in dealing with the "motive" axis is where to place Nihilists. Could be at the top or the bottom. Regardless, Nihilist groups pose major challenges for EBO.

Groups are not static in this analytic space. They move up and down each dimension with time. One analytic challenge is to map the movement of many groups in the space and look for patterns. A single group may also occupy several different parts of this space at the same time. Should we do multi-dimensional scaling to see if we have captured the key dimensions?

Complicating Dimensions

- ◆ Networks not physical objects
- ◆ Capability and Will
- ◆ Degree of Local Support
- ◆ Time/Data Availability



Networks are the target in counter terrorism not physical objects as they were in previous wars — such that it is now more important to track money flows than it is to know where the power plants and transformers were located outside of Baghdad. This underscores the value of an EBO approach. In counter terrorism analysis, the analysis is focused on networks such as:

- Money Flow
- Recruitment
- Training
- Communications
- External popular support
- “Enhanced infrastructure”

Capability and Will

Will is often as important or more important than capability. Leadership is a critical sub-division.

Degree of Local Support is the willingness of local population to protect, support and join terrorist groups. They cannot attain success unless the local population supports them or at least acquiesces in their presence. Safe places can range from geographic territory (Afghanistan for Al-Qaeda) to an apartment or “space on the internet.”

Time Data Availability

- Immediate, tactical, data-based, data driven
- Short termed, analytic, data gaps
- Long term Predictive, no data

Question 2

◆ What are indicators of success for counter terrorism?

- Leading Indicators:
 - » Number/location of safe havens, actions of governments to battle the level of terrorist (organizational) activities
 - » New ideas from new groups will come up with attacks/methods we are not looking for
 - ◆ Need creative thinking to capture these types of ideas, however, we want to be careful not to plant ideas
- Lagging Indicators:
 - » Frequency, intensity and complexity of attacks



Leading indicators are indicators you can attempt to see prior to an attack. They indicate the level of preparatory activity on the part of the terrorist organization. There are many things that can probably be monitored and measured, however the wild card factor in all of this is the extent of human imagination. There are a limitless number of targets in the world, and there is always the possibility that an organization is waiting for this war to be declared won, or even a partial victory, after which another attack could take place to lessen the American peoples' confidence in the validity of such statements, therefore heightening the psychological effect of such an attack.

Lagging indicators are more traditional measures such as frequency, intensity and complexity of operations.

Question 3

- ◆ What tools and techniques are available to apply this analysis?
 - Network analysis
 - Statistical analysis
 - Classification algorithms
 - Agent-based models
 - Generative analysis heuristic search techniques



These tools are in use in different ways and at different levels. They have been proven valuable in the past, and with some work should prove valuable in the future study of counter terrorism.

Question 4

What shortfalls exist in the set of tools and techniques?

- ◆ Better techniques for managing large volumes of unstructured data/reporting, including:
 - Rapidly identify patterns and associations
- ◆ Deal with very complex and non-linear problems
- ◆ Richer databases with information on individuals, groups, state sponsors and networks
 - Flows of money, Communications, etc.
- ◆ Tools for Perception Management
 - Preventing visible successes
- ◆ Interagency cooperation, integration and communication
 - Use a consistent ontology
- ◆ Conceptual Modeling
 - Develop Taxonomies
 - Understanding leadership
 - Cultural anthropology and psychological background of a terrorist



Overriding Theme: We need different tools for different parts of this problem.

Which tools are valuable for each kind of analysis?

Can they identify drivers/inhibitors that move a group along a scale?

We need to look at both macro and micro levels of the network.

Agent based modeling can be used to fill in data gaps.

Historical Analysis suggests we should look for analogs.

In what circumstances is pre-9/11 knowledge applicable to post-9/11 world
(Thinking in Time Neustadt and May).

We need to develop red cell techniques.

Current problems and future threats may require two different sets of tools.

Domestic perception management — we need to know how to deal with cascading effects including; psychological, physical, training leaders (local and national) to deal with mass casualties, not allowing anxiety to continue and grow.

Question 5

◆ **What recommendations do you have to improve existing effects based analysis capabilities?**

- Analysis, data and tools should be kept at the lowest classification possible/open source
- Enhance interagency and international cooperation/collaboration
- Precisely manage the presentation of available information
- Red team - more robust and imaginative red team process
- Enlist people outside the MORS community to accomplish these goals
 - » Need behavioral scientists and political scientists; expand into other areas
 - » Use historical data to determine how to use information sources better



Need a set of coherent, sharable databases of intelligence information from multi-agency and international sources organized in a fashion that enables analysis in a timely fashion.

Need an interagency process that integrates all the elements of national power and deals with security issues to foster the sharing of information.

Need Red Team and models that incorporate terrorist culture and intentions (think outside the box).

Need to use historical data to determine how to use information sources better (i.e., it appears that info was available that September 11 attacks were possible but the information could not be integrated in a timely fashion).

Need to structure problem space to begin to analyze it.

Need to be able to determine the best way to disrupt the terrorist group process.

MORS Workshop

Analyzing Effects-Based Operations

Synthesis Panel

31 January 2001

Booz Allen Hamilton, McLean, VA



This chapter contains the report of the Synthesis Panel for the MORS Workshop “Analyzing Effects-Based Operations,” conducted at Booz Allen Hamilton, McLean, VA, 29-31 January 2002.

Agenda

- ◆ Panel Goals, Composition, Plan of Attack
- ◆ Insights on Nature of the Problem
- ◆ Selected Findings, Recommendations
- ◆ Summary



The Synthesis Panel report consists of four sections.

As a context, the first section identifies the goals and scope of the Synthesis Panel, the composition of the Synthesis Panel, and the plan of attack that the Panel adopted.

The second section summarizes insights on the nature of the problem that the Synthesis Panel derived. These insights were developed from the remarks of the plenary speakers, the internal discussions of the Synthesis Panel members, and the deliberations of the other six working groups.

The third section formulates selected findings and recommendations based on the workshop deliberations.

The final section briefly summarizes key observations and conclusions.

Panel Goals, Objectives

◆ Goals

- Develop a better understanding of *analyzing Effects Based Operations*, from a holistic perspective

◆ Objectives

- Clarify the nature of the problem by conducting internal panel discussions
- Capture the “state-of-the-practice” based on the presentations at the mini-symposium
- Derive key findings and recommendations by integrating across the results of the individual panels



The Synthesis Panel had one major goal: to develop a better understanding of analyzing Effects Based Operations, from a holistic perspective.

Consistent with that goal, the Synthesis Panel pursued three supporting objectives. First, it sought to capture the “state-of-the-practice” in analyzing EBO, based on the presentations at the mini-symposium. Second it sought to clarify the nature of the problem, based on internal panel discussions. Finally, it derived key findings and recommendations based on an integration across the results of the individual panels.

Recruiting Was Tough...



“But I don’t want to do Effects Based Analysis!”



As many of you know, members of the Synthesis Panel have a “daytime job” and a “night-time job.” During the day, each member of the panel is assigned to one of the six mission oriented working groups. During off-hours we meet to share insights and develop a holistic view of the subject. Thus, recruiting can be difficult, requiring unorthodox approaches.

Panel Composition

- ◆ Gary Horne (MITRE)
- ◆ Jerry Kotchka, FS (Lockheed-Martin)
- ◆ Denny Leedom (EBR)
- ◆ Roy Rice (TBE)
- ◆ Peter Sharfman (MITRE)
- ◆ Cy Staniec (Northrop Grumman)
- ◆ Steve Starner (BAH)
- ◆ Stuart Starr, FS (MITRE)
- ◆ Chuck Taylor (OSD(C3I))

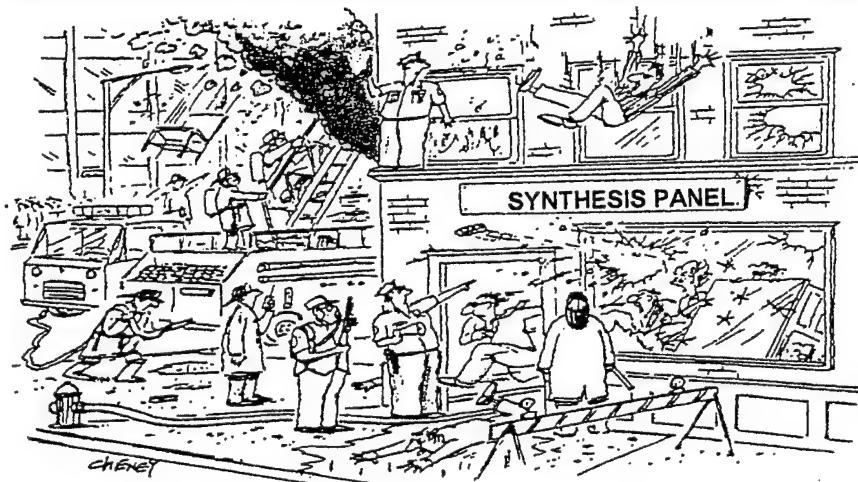


The above list identifies those individuals who ultimately “volunteered” to participate on the Synthesis Panel. Each of Panel member also participated in the deliberations of one of the other six working groups.

The following representation was provided on the panel:

- Government -- 1
- FFRDCs -- 3
- Private industry -- 5

Synthesis Panel: Concept of Operations



In contrast to the other working groups, the Synthesis Panel was very tactical in its operations (i.e., it responded to the “crisis de jour”).

Agenda

- ◆ Panel Goals, Composition, Plan of Attack
- ◆ Insights on Nature of the Problem
- ◆ Selected Findings, Recommendations
- ◆ Summary



The Synthesis Panel developed insights on the nature of the EBO assessment problem by taking advantage of several sources. This section briefly summarizes those findings in the following areas:

- Broad insights developed by the Synthesis Panel through its panel deliberations. The Panel observed that with the conclusion of the Cold War, a new DoD context is emerging. Within this context, new assessment challenges are emerging for the analyst. Based on these new challenges, a new agenda is emerging for EBO assessment.
- Insights acquired through the presentations at the Mini-Symposium.
- Insights acquired and captured in the other WG discussions. The Synthesis Panel assembled several insights that were identified in one or more of these working groups.

Observations About EBO: Who?

- ◆ Who must be considered in an EBO assessment?
 - Blue (military, other government organizations, public)
 - Red (military, other government organizations, public)
 - Neutrals
 - Blue, Red allies and coalitions
 - Other countries that are involved, but not participating in combat operations
 - International Organizations (IO)
 - Non-Governmental Organizations (NGO)
- ◆ Observations
 - Potentially a *large* number of diverse entities must be considered
 - This poses challenges in dealing with an *array* of consequences; e.g., intended, unintended, higher order

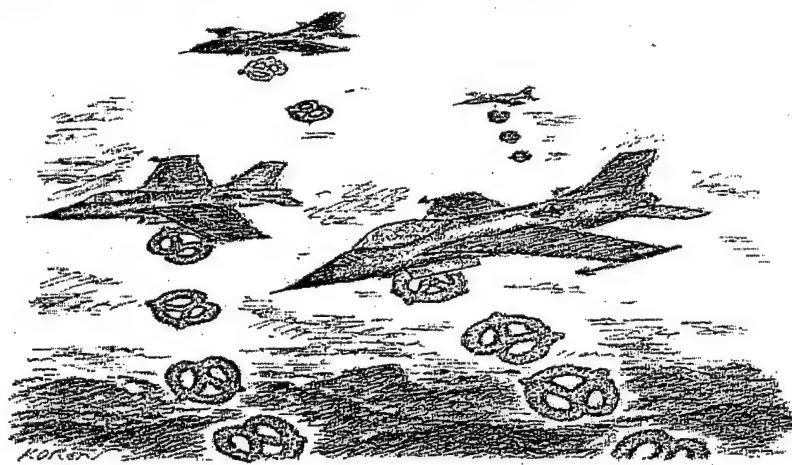


Observations About EBO: How?

- ◆ A broad set of actions may be employed to implement EBO; e.g.,
 - Diplomatic
 - Informational
 - Military
 - Economic
 - Social/Humanitarian
 - Judicial
- ◆ Observations about potential EBO actions
 - *Both* Blue and Red are likely to employ the full set
 - The particular selection of actions will reflect the capabilities and culture of both sides



EBO Must Be Creative and Agile...



The Workshop emphasized that the techniques employed in EBO must be creative and agile. For example, this slide suggests that new insights (e.g., the recent revelation that pretzels can induce momentary unconsciousness) should be employed in novel ways.

Results from the Mini-Symposium

- ◆ What is EBO?
- ◆ What are the key attributes of EBO?
- ◆ How should we analyze EBO?
- ◆ Some take-aways



What Is EBO?

- ◆ “EBO is a way of thinking” (Maj Gen Deptula)
- ◆ “EBO is a movement ... a revolt of the warfighters ... a grand challenge for analysts ... an opportunity to think differently” (Paul Davis)
- ◆ “EBO provides a common frame of reference between DoD and other Agencies” (Graham Kessler)
- ◆ “EBO coordinates sets of actions directed at shaping the *behavior* of friends, foes and neutrals in peace, crisis and war” (Ed Smith)



What Are The Key Attributes of EBO?

- ◆ EBO are inherently *multi-sided* (Lee Wagenhals, Ed Smith)
- ◆ Effects are
 - Ultimately *behavioral*
 - *Dynamic, cascading*
- ◆ EBO are inherently *complex, multi-dimensional*: eg,
 - Cuts across multiple levels (e.g., strategic, operational, tactical)
 - Involves multiple communities (e.g., political, economic)
- ◆ “EBO are absolutely necessary, but fraught with uncertainty ... the analyst must highlight this uncertainty” (Len Hawley)



How Should We Analyze EBO? (1 of 2)

- ◆ “*Analysis principles*” include
 - Mission-system capability assessments (considering DOTML-PF)
 - The need to represent probability/randomness
 - The criticality of exploratory analyses” (Paul Davis)
- ◆ Speakers highlighted a broad spectrum of *relevant tools*;
e.g.,
 - “(A tool chest including)
 - » Qualitative models
 - » Mining of history
 - » Structured games, experiments
 - » Agent Based Modeling
 - » Multi-resolution, multi-perspective models” (Paul Davis)



How Should We Analyze EBO? (2 of 2)

- ◆ Relevant tools (concluded)

- Influence nets in conjunction with Colored Petri Nets (Lee Wagenhals)
- Computational social science tools (Dez Saunders-Newton)
- Complex Adaptive Systems/state space analysis techniques (e.g., chaotic control theory, evolutionary game theory) (Mike Senglaub)
- Leontief Input-Output Models (Capt Tony Snodgrass)

- ◆ Additional observations (Dick Hayes)

- We need tools that can handle phenomena that are non-linear, probabilistic
- Consider adopting a satisficing, vice an optimizing, approach



Some Take Aways...

- ◆ “Do it wisely and do it well” [e.g., make good decisions, throughout the full cycle; go beyond DIME, build coalitions] (Brent Scowcroft)
- ◆ “Precision weapons will require precision information; if you don’t have precision information you will accurately hit the wrong target” (Barry Watts)
- ◆ “EBO involves C3 (i.e., complexity, controversy, confusion)” (Len Hawley)
- ◆ “We are behind... and it’s your fault!” (MG Cash)



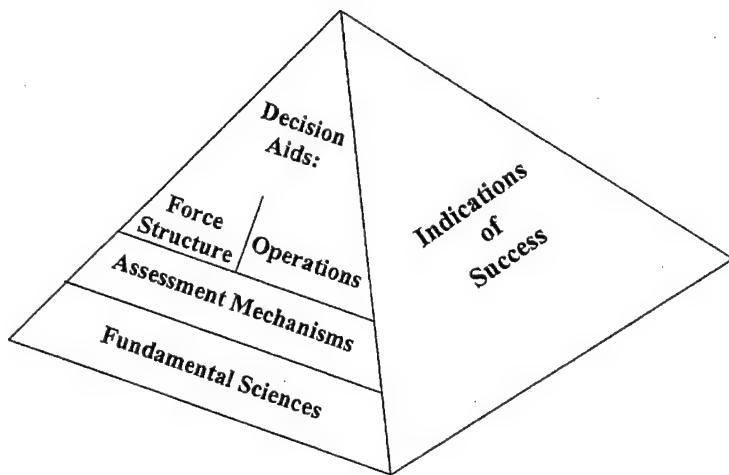
Agenda

- ◆ Panel Goals, Composition, Plan of Attack
- ◆ Insights on Nature of the Problem
- ◆ Preliminary Findings, Recommendations
- ◆ Summary



This section of the report describes the preliminary findings and recommendations that have emerged from the workshop.

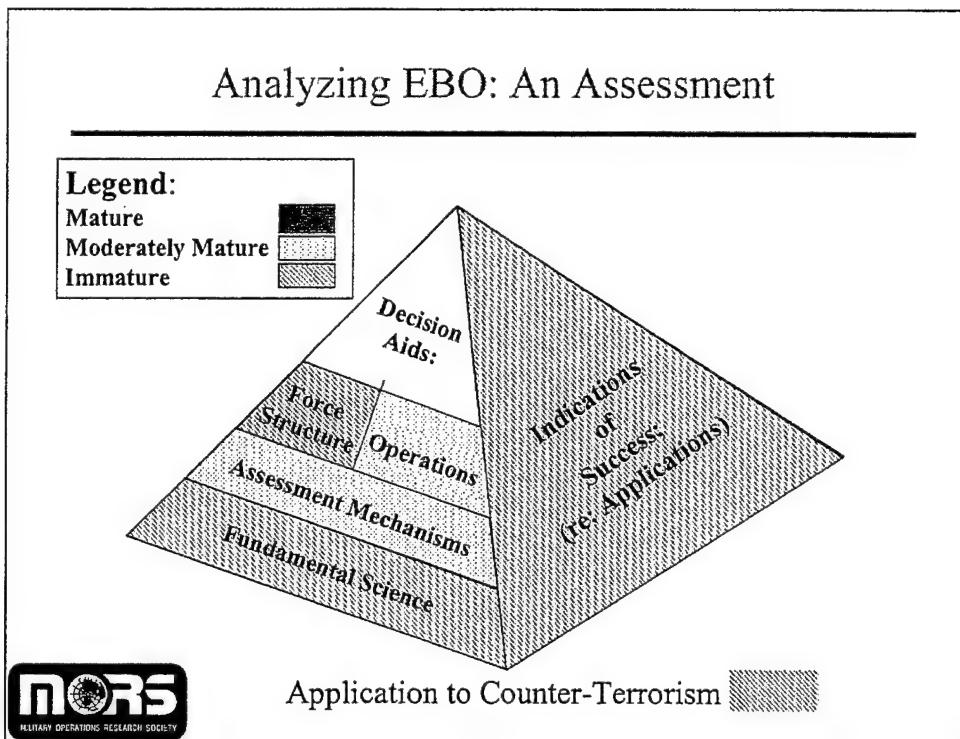
Workshop Panel Structure



WG 6: Effects Based Analysis of Counter Terrorism

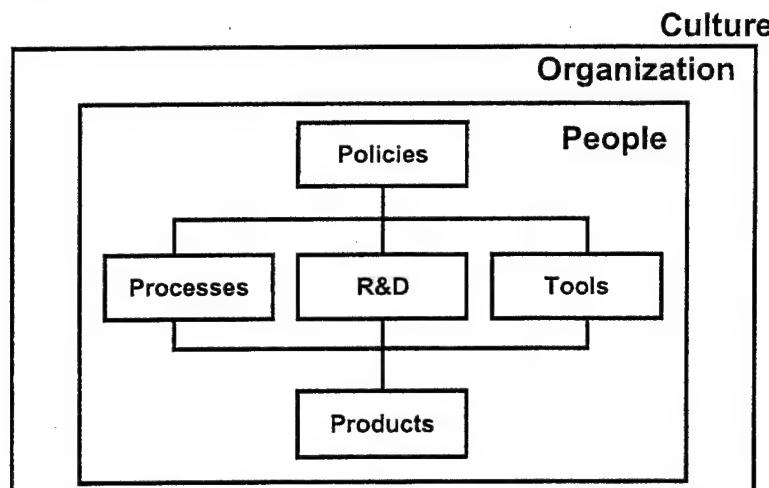
This chart depicts the relationship among the other six working groups in the workshop.

Analyzing EBO: An Assessment



Based on the deliberations of the other panels, this chart depicts the perceived maturity of each of the panel areas.

Framework for Recommendations



The accompanying figure provides a business process re-engineering perspective of EBO assessment. The Synthesis Panel concluded that if EBO is to be planned and conducted successfully in a dynamic environment *and* be supported effectively by the analytic community, we must consistently address *all* of these factors. The backdrop for these factors is set by the *cultures* of the many communities that must participate in EBO assessments of “New World Disorder” missions. It was recognized that in many mission areas DoD would not have the lead responsibility. Thus, we must be cognizant of the cultures of the other participants and flexible in our interactions with them.

Second, *people* are critical components of future C4ISR assessments. This implies the need to provide critical Education and Training (E&T) for both the analysts and the recipients of those analyses. Within this framework, key *policies and concepts* must be formulated that recognize the cultural heterogeneity of the participants and seeks to bridge those differences. This establishes the context for four key areas: 1) the *data* needed to support the assessments; 2) the *tools* that are required to treat adequately the nature of the EBO problem; 3) the *processes* that are employed in performing the assessments and supporting key institutional activities; and, 4) the *R&D* that is needed to address critical conceptual shortfalls.

Finally, key *products* are needed to document and encourage the production of exemplary EBO assessments by the community.

Key Recommendations (1 of 6)

◆ Culture

- The military needs to adopt the appropriate EBO Measures of Merit (MoM)
 - » *NOT* “How many things are broken and how many people are killed”
 - » *BUT* “Did military action lead to achievement of national objectives (Measures of Policy Effectiveness (MoPE))”
- Initiate actions (e.g., meetings, coordination efforts, socialization) to *breakdown barriers with the diverse communities* who must participate in EBO assessments



Culture. Most of the mission-oriented WGs observed that DoD would have to work with a large and diverse set of other organizations to perform credible EBO assessments (e.g., in support of EBO assessments of counter terrorism, the DoD would support organizations such as the Department of Justice and the Federal Emergency Management Agency (FEMA)). Consequently, actions should be initiated to break down the cultural barriers with these diverse communities. As one preliminary step, it would be highly desirable if MORS were to conduct one or more multi-community workshop on “New World Disorder” EBO Assessment, at the *unclassified* level. It might be appropriate to conduct such workshops with other professional organizations that are sensitive to the cultures of the other key participants. For example, if a workshop were to be held on EBO assessment in the context of peace operations, it might be advisable to team up with the Cornwallis Group, which has strong ties both to MORS and the peace operations community.

Key Recommendations (2 of 6)

- ◆ People -- Analysts
 - Develop curricula, programs to *enhance education and training for the military operations analyst*, emphasizing
 - » Breadth of education (e.g., broader exposure to social sciences)
 - » Training in emerging tools (and COTS products)
 - » Exposure of analysts to effects-based operations (MORS, NDIA)
 - Enlist the support of a broad spectrum of *social scientists* (who may need education on national security, OA perspectives)
- ◆ People – Decision makers
 - Decision makers need to be educated about what EBO analysts can, and can *not*, provide



People. Nearly every WG emphasized the education and training challenges that the analyst faces in dealing with “New World Disorder” EBO assessments. First, the issues in question require a much broader knowledge base than that of the typical analyst. For example, the assessment of peace operations requires an in-depth understanding of the social sciences (e.g., demography, sociology, anthropology, political science). Second, a significant new generation of EBO tools and methodologies is emerging. Some mechanism is needed to train analysts on the proper use of those tools. Finally, there is a need to expose analysts to operations (either real or simulated) to sensitize them to the realities of “New World Disorder” conflict.

To deal with the first two issues, it would be appropriate for the military schools and universities (e.g., NPS, AFIT, NDU) to develop curricula to support broader E&T. One option for enhancing the breadth of Operations Analysts (OA) is to attract new analysts with social science training and provide them with the E&T needed to acquire needed quantitative skills.

Key Recommendations (3 of 6)

◆ Organization

- Identify an organization that can provide community focus on the analysis of EBO; e.g., serve as a
 - » Clearinghouse/repository
 - » Stimulator/coordinator of R&D across government, academia, industry, professional societies
- Perform several, mutually consistent reorganizations:
 - » J-Staffs to functionally-integrated staffs (GEN Wilhelm)
 - » Analysis groups to multi-disciplinary teams
- Encourage interagency, international cooperation

◆ Policies

- We must reassess existing policies which severely restrict the flow of data, information across institutional barriers -- *rebalancing* security concerns and the need to know



Policies. Several WGs observed that existing policies severely restrict the flow of data and information across the institutional barriers that separate the participating communities. For example, in counter terrorism operations, organizations at the federal, state, and local level will participate, as well as commercial entities (e.g., CHEMTREC). Current security policies and procedures significantly restrict the dissemination and sharing of critically needed information among those participants. There is a need for the government to undertake a fresh rebalancing of security concerns and the need to know.

Data. Every WG identified data availability as one of the key impediments to effective EBO assessment. To redress this issue, a recommendation made at SIMTECH 97 (and reiterated at SIMTECH 2007) should be implemented and extended. Those workshops recommended that a comprehensive DoD-wide program should be undertaken to provide the verified, validated and certified data needed for assessment. In view of the involvement of communities that transcend the DoD in EBO assessments, that recommendation should be broadened to include the data of other relevant communities, where feasible. The DSC is well-positioned to initiate this activity. However, because the data in question goes beyond that of DoD (e.g., involving data controlled by other executive agencies, IOs, NGOs) it may require the efforts of an organization with a broader charter.

Key Recommendations (4 of 6)

- ◆ Tools -- Expand the analyst's "tool chest" to support the assessment of EBO
 - Begin by
 - » Selecting "best of breed" products (e.g., GMU's Caesar II, NISAC's infrastructure assessment tools)
 - » Adapting selected commercial products (e.g., SIMCITY)
 - » "Normalizing" these tools so that they are mutually consistent (e.g., consistent data bases, MoM)
 - Conduct research to compensate for key shortfalls
 - Employ an evolutionary acquisition approach to
 - » Add new functionality
 - » Reflect lessons learned from analyst usage
 - » Fold in the results of research activities



Tools. A number of WGs observed that the traditional attrition-based approaches to analysis are not relevant to key "New World Disorder" missions. There is the need for an analyst "tool chest" to support the assessment of EBO. It is proposed that this tool chest be developed in an evolutionary manner (e.g., begin with a preliminary normalized set of tools; conduct research to compensate for key shortfalls; employ an evolutionary acquisition approach to add new functionality, reflect lessons learned from analyst usage, and fold in the results of research activities).

Key Recommendations (5 of 6)

◆ R&D

- Recast and continue to pursue the recommendation made at SIMTECH 1997 (and reiterated at SIMTECH 2007 and C4ISR Assessment Workshops) to develop a *comprehensive DoD-wide program to perform research into "soft factors"* (e.g., reason, belief)
- Derive "lessons learned" from prior efforts to perform EBO, considering the perspectives of *all* relevant parties to the operation
- Conduct historical and social science research to assess the relationship among potential causes (e.g., DIME) and effects (e.g., the assessment of the impact of the strategic bombing campaign in World War II)



R&D. In SIMTECH 97 it was recommended that a comprehensive DoD-wide program should be undertaken to perform research into "soft factors." In SIMTECH 2007 it was observed that little R&D into "soft factors" had been undertaken during the past decade and they reiterated the importance of undertaking such a comprehensive program. That recommendation is of continuing relevance. It would be appropriate for DMSO, in concert with appropriate research organizations (e.g., ONR, DARPA), to champion such a comprehensive program.

Key Recommendations (6 of 6)

◆ Processes

- Explore options to facilitate the tasking of the Intelligence Community to monitor indications of success (and failure), responsively, in near real time, to guide EBO
- Revise the PPBS and Weapon System Acquisition Process to incorporate EBO thinking

◆ Products

- Encourage analysts to share "best of breed" EBO analyses; e.g.,
 - » MORS should devote a *special issue of Military Operations Research* to analyses of EBO



Processes. In order to monitor indications of success, responsively, it will be important to establish near real time processes to task the Intelligence Community. In addition, if the philosophy of EBO is to be reflected in force sizing activities, it is important to incorporate that philosophy into the PPBS.

Products. There is a need to provide a set of exemplary products to the community to help guide improved EBO assessments. One useful step would be to devote a special issue of the journal *Military Operations Research* to the application of EBO to selected case studies.

Agenda

- ◆ Panel Goals, Composition, Plan of Attack
- ◆ Insights on Nature of the Problem
- ◆ Key Findings, Recommendations
- ◆ Summary



This section briefly summarizes some of the Synthesis Panel's major observations and conclusions.

Summary (1 of 3)

- ◆ There is confusion about
 - The definition of EBO
 - The language employed to discuss it
- ◆ This is understandable because EBO is inherently complex and multi-dimensional, with respect to
 - Decisions/activities supported
 - Levels (e.g., strategic, operational, tactical)
 - Objectives (e.g., political, military, economic, social)
 - Players (e.g., Blue, Red, Neutral)
 - Alternative possible actions/reactions
 - Possible outcomes/effects



It is important to emphasize the EBO are inherently a multi-party problem. Thus, it must be recognized that EBO can not be treated as a one-sided assessment.

It was notable that nearly all of the working groups emphasized four areas where shortfalls limit our ability to perform effective EBO assessments: 1) educating and training the analyst; 2) acquiring needed data; 3) coping with “soft factors” (e.g., representing reason and belief in our assessments); and, 4) creating a flexible, tailorable analyst “tool chest.”

As a minimum, coordinated cross-community efforts are needed to begin to address these issues systematically. It is important that these efforts extend beyond the DoD because of the important roles that other organizations play in EBO.

Summary (2 of 3)

- ◆ Four of the “longest poles in the tent” have been emphasized in nearly every WG
 - *Educating/training* the analyst
 - Coping with “*soft factors*” (i.e., reason, belief)
 - Creating a flexible, tailorable analyst “*tool chest*”
 - Deriving *cause and effect* relationships
- ◆ It is notable that “one dog did *not bark*” -- the need for data; however, remember that
 - Theory without data = philosophy
 - Data without theory = noise



Summary (3 of 3)

- ◆ It is maintained that our fundamental analysis process is applicable to EBO; however, it
 - Mandates that we return to our roots and adopt multi-disciplinary approaches
 - Challenges us to develop appropriate measures and indicators of success/progress
 - Recognizes that we do not do a good job in treating reason and belief in our analyses
 - Demands that our methodologies are based on probabilities/liabilities (giving rise to probabilistic results)



Scorecard

◆ Positives:

- The Workshop served to clarify the nature of the problem of *analyzing EBO*
- To paraphrase the psychiatrist in "Portnoy's Complaint": "Now, we are ready to begin..."

◆ Residual Challenges

- Analysis of EBO is not yet a *discipline*; there is a need
 - » For a better definition of the problem
 - » For more decision maker-analyst interaction
 - » To link our theory to our data
- There is a need to reach out to a broader community to participate on multi-disciplinary analysis teams
- There is a need to generate a Plan of Action and Milestones (POA&M) to focus, mobilize the analysis community



A Test

- ◆ Suppose that you were asked to generate a one year curriculum to prepare the next generation of analysts to become EBO analysts
- ◆ What would you include in the curriculum?
- ◆ Why?



EBO Problems Tend to be Complex, Poorly Defined



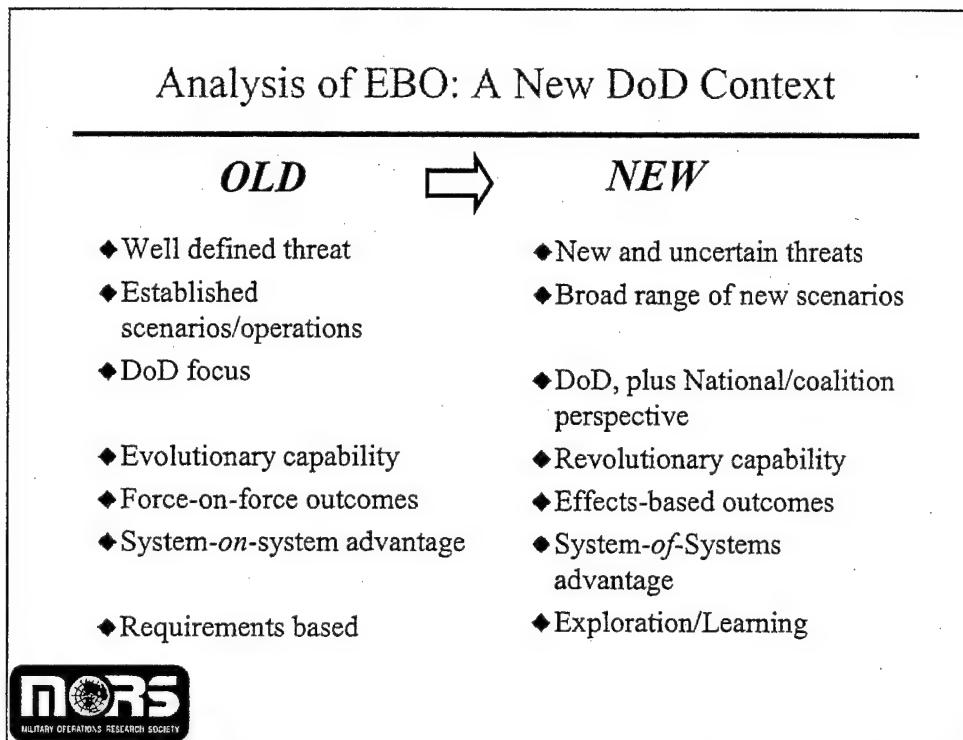
"Vacuums, black holes, antimatter, Effects Based Analyses —
It's the elusive and intangible which appeals to me"



Back-up Slides



Analysis of EBO: A New DoD Context



Today's analysts find themselves in a new national security context. This slide highlights some of the dramatic shifts that have occurred since the end of the Cold War. Having the Soviet Union as the single dominant adversary over a protracted period provided a sustained focus for intelligence gatherers and force planners so that they could refine US understanding of many aspects of Soviet capability and behavior. This is in stark contrast to the "New World Disorder" in which a broad range of varied and uncertain threats have made it difficult to anticipate issues and focus intelligence resources appropriately.

As a consequence of the Soviet focus, a relatively few scenarios and types of operations were sufficient for assessment and planning. Today the US is faced with a broad set of operations and missions that include peace keeping, coercive operations, anti-terrorism, small-scale contingencies and major theater conflicts.

With the exception of the NATO allies, DoD was mainly concerned with operations that involved only the four Services. Many operations today require a much larger contingent of participants, including numerous non-NATO allies, various national government organizations, International Organizations (IOs), and Non-Governmental Organizations (NGOs).

Until now, war fighting capability has evolved incrementally with the addition of each new weapon system. However, information technology and precision weaponry has the potential of changing the nature of warfare in revolutionary ways.

New DoD Assessment Challenges

OLD



NEW

- | | |
|--|---|
| <ul style="list-style-type: none">◆ Threat based planning◆ Refining established notions
◆ Benefits of new capabilities◆ Firepower-centric◆ Assessing force structure
◆ Collection of <i>ad hoc</i> issues◆ Tractable focus | <ul style="list-style-type: none">◆ Capability based planning◆ Exploring transformational possibilities
◆ Understanding fundamentals◆ Speed-centric◆ Mission capability packages (e.g., DOTML-PF; DIME)
◆ Hierarchy of related issues◆ Exploding complexity |
|--|---|



Shifts in the national security context have resulted in major changes in the challenges faced by analysts who are attempting to assess military capabilities, particularly EBO capabilities which play a critical role in force transformation and new war fighting concepts. Some of the key changes are highlighted in this slide.

In the old context, analysts could focus on means of countering a specific threat. Today they must address capabilities that can be used in an agile manner to deal with a range of threats. Similarly, because of the stability of the threat and the evolutionary nature of military capability, analysts used to refine established operational concepts and capabilities. This contrasts with the current challenge where analysts must explore completely new war fighting concepts like distributed C2 for the nonlinear battlespace.

In the past, analysts could focus on the benefits of adding a new weapon system to the force mix. Today, they must understand the fundamentals associated with networking the force or sharing information through a common operational picture. In addition, assessments used to be focused on force mix/structure issues. Today, assessments must address new mission capability packages, including all the dimensions of Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel and Facilities (DOTML-PF). Previously, analytical capability was often focused on *ad hoc* issues that arose in the budget process. Today there is a need for a systematic multi-level assessment of a comprehensive set of related issues. Finally, the expanded dimensionality reflected in the above factors combined with the increase in the number of players translates into significant growth in problem complexity.

Assessing EBO Implications: A New Agenda

- ◆ A new, more comprehensive *analytical construct*, requiring
 - Characterization of new missions
 - Metrics/methods for effects based outcome
 - Representations of soft factors (e.g., reason, belief)
- ◆ New *assessment capabilities*
 - An expanded analyst tool chest (e.g., address non-lethal/indirect effects, broader outcomes)
 - Data for new dimensions
 - Education and training (E&T)
- ◆ New *culture/processes*: coupling to
 - Political/military outcomes
 - New participants
 - New operational concepts
 - Mission assessment



The changes in DoD's context and associated assessment challenges have profound implications for the EBO assessment community. As indicated in this slide, a new agenda is needed with improvements in three areas: 1) a more comprehensive analytical construct; 2) new assessment capabilities; and, 3) a new culture/process for assessment. The highlights for each are discussed below.

More Comprehensive Analytical Construct. The NATO Code of Best Practice (COBP) is a good starting point for describing how to conduct a EBO assessment. However, DoD must extend this guidance in a number of important ways. New missions such as peacekeeping, counter terrorism, and coercive operations need to be characterized in terms of scenarios, operational concepts, command and control decisions, and information needs. In addition, a hierarchy of metrics and methods must be developed for measuring the impact of information superiority on effects-based operational outcomes. Finally, soft factors such as cognitive decision making, based on both reason and belief, must be represented better in our assessments.

New Assessment Capabilities. DoD will need to develop fundamentally new assessment capabilities. This will require the systematic collection of data for various aspects of new systems and concepts associated with EBO, information superiority, and mission capability packages. At the same time, a new generation of analysts will have to be educated and trained to address the new challenges identified earlier. A mix of new tools, including information-sensitive modeling and simulation (e.g., agent based simulations) and exploratory modeling and analysis, will have to be evolved or developed.

New Culture and Processes. Finally, there is the need to establish a new culture of openness and cooperation in which data are readily published and shared and participants from many different communities are motivated to collaborate across traditional organizational boundaries. In this new environment, the EBO community will have to work cooperatively with the many new participants as well as those from the mission assessment and experimentation communities.

Illustration of Potential Blue EBO Actions

- ◆ Diplomatic (e.g., negotiations, demands, treaties, coalition building)
- ◆ Informational (e.g., computer network offense and defense; psyops; shaping the news)
- ◆ Military (e.g., strategic force posturing, application of conventional (lethal, non-lethal) forces, special forces, leverage “other people’s armies”)
- ◆ Economic (e.g., blockade)
- ◆ Humanitarian (e.g., relief efforts, such as dispersal of emergency food supplies)
- ◆ Judicial (e.g., set up new processes such as military tribunals)



Illustration of Potential Red EBO Actions

- ◆ Diplomatic (e.g., threats, demands; restrict use of territory, airspace)
- ◆ Informational (e.g., propaganda, jamming Blue message)
- ◆ Military (e.g., conventional forces; asymmetric actions (e.g., terrorism, anti-access/area-denial, WMD, infrastructure attack))
- ◆ Economic (e.g., restrictions on sale of critical materials such as oil)
- ◆ Social (e.g., issue fatwas, call for jihad)



Selected Issues: Perception Management

- ◆ Blue faces a number of daunting challenges
 - Friction across organizational lines (e.g., difficulty in “speaking with a single voice”)
 - Free press reporting Red propaganda
- ◆ Red may be more strongly positioned
 - Tight control of the press
 - Single point of contact to articulate message
- ◆ This asymmetry must be addressed in the analysis of EBO



Selected Issues: Feasibility in Implementing EBO

- ◆ How well can you synchronize actions
 - Within a discipline (e.g., orchestrating military actions in the face of the fog/friction of war)?
 - Across disciplines (e.g., dealing with last minute modifications in ATOs by coalition partners)?
- ◆ Is it feasible, with moderate confidence/risk, to understand the relationships between
 - Individual cause and effect (e.g., public response to strategic bombing)?
 - Multiple causes and effects/interactions (e.g., near-synchronized DIME actions)



Selected Issues: Feasibility in Implementing Analyses of EBO

◆ Hypotheses:

- “EBO is analytically tractable for a selected set of adversaries (e.g., rational opponent with limited options to resist) and not others (e.g., “irrational” opponent, from selected cultures, with many options to resist)”
- “EBO analysis is only possible when we have a reasonably clear understanding of the culture and mindset of our opponents”
- “If EBO is to be understood well enough to be analyzed, you must deal with relatively simple systems”
- “EBO is tractable for *qualitative* assessment; it remains to be proven that it is tractable for *quantitative* assessment”



Analyzing Effects-Based Operations
Workshop Report
29-31 January 2002
Booz Allen Hamilton, McLean, Virginia

Appendix A — Acronyms

ACC/DO	Air Combat Command/ Director of Operations
AFDD	Air Force Doctrine Document
AFIT	Air Force Institute of Technology
AFOTEC	Air Force Operational Test and Evaluation Center
AFRI	Approved Force Retention Increment
AFRL	Air Force Research Laboratory
AFSAA	Air Force Studies and Analysis Agency
AOC	Air Operations Center
ASD/C3I	Assistant Secretary of Defense/ Command, Control, Communications and Intelligence
ATO	Air Tasking Order
AUS	Australia
AWOS	Air War Over Serbia
BA&E	British Aerospace
BAH	Booz Allen and Hamilton
BDA	Battle Damage Assessment
C2	Command and Control
C3	Command, Control and Communications
C3I	Command, Control, Communications and Intelligence
C4ISR	Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance
CAA	Center for Army Analysis
CAOC	Combined Air Operations Center
CBRN	Chemical, Biological, Radiological, and Nuclear
CCIR	Command and Control Information Requirements
CCRP	Command and Control Research Program
CIA	Central Intelligence Agency
CINC	Commander in Chief
CINCPAC	Commander in Chief – Pacific Fleet
CNN	Cable News Network
COA	Course of Action
COBP	Code of Best Practice (NATO)
CONOPS	CONcept of OperationS
COP	Command Operating Program
COTS	Commercial Off The Shelf
DARPA	Defense Advanced Research Projects
DIAMOND	Development and Integration of Accurate Mathematical Operations in Numerical Data-Processing (UK)

DIME	Diplomatic, Information, Military, Economic
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense (US)
DoS	Department of State (US)
DOTML-PF	Doctrine, Organization, Training, Materiel Leadership — Personnel and Facilities
DRC	Dynamics Research Corporation
DSC	Digital Source Collector (US Army)
DSTL-UK	Defence Science Technology Laboratories
DSTO	Defence Science and Technology Organisation (Australia)
E&T	Education and Training
EBO	Effects-Based Operations
EBR	Evidenced Based Research
ELF	Earth Liberation Front
FAQ	Frequently Asked Questions
FARC	Fuerzas Armadas Revolucionarias de Colombia (Revolutionary Armed Forces of Colombia)
FEMA	Federal Emergency Management Agency
FFRDC	Federally Funded Research and Development Center
FON	Freedom of Navigation (operations)
FOP	Financial Operating Plan
FS	MORS Fellow of the Society
GAM	Gerakin Aceh Merdeka (Free Aceh Movement; Indonesian insurgent group)
GMU	George Mason University
H/W	Hardware
IDA	Institute for Defense Analyses
IITRI	IIT Research Institute
IO	International Organizations
IOS	Intelligence Operations System
IPB	Intelligence Preparation of the Battlefield
IRA	Irish Republican Army
ISR	Intelligence Surveillance and Reconnaissance
IT	Information Technology
IW	Information Warfare
JFCOM	Joint Forces Command
JHU/APL	Johns Hopkins University Applied Physics Laboratory
JOC	Joint Operations Center
JT&E	Joint Test and Evaluation
JTF	Joint Task Force
JWAC	Joint Warfare Analysis Center
LER	Loss Exchange Ratio
M&I	Modernization and Improvement
M&S	Modeling and Simulation
MCCDC	Marine Corps Combat Development Command
MoE	Measures of Effectiveness

MoFE	Measures of Force Effectiveness
MOM	Measures of Merit
MoPE	Measures of Policy Effectiveness
MORS	Military Operations Research Society
MORSS	Military Operations Research Society Symposium
NASM	National Air and Space (Warfare) Model
NATO	North Atlantic Treaty Organization
NCA	National Command Authority
NDIA	National Defense Industrial Association
NDU	National Defense University
NGIC	National Ground Intelligence Center
NGO	Non-Governmental Organizations
NIH	"Not Invented Here"
NISAC	National Infrastructure Simulation and Analysis Center
NPS	Naval Postgraduate School
NSC	National Security Council
NWDC	Navy Warfare Development Command
OA	Operations Analyst
OAS	Office of Aerospace Studies
ONA	Operational Net Assessment
ONR	Office of Naval Research
OOTW	Operations Other Than War
OPEC	Organization of Petroleum Exporting Countries
OR	Operations Research
ORSA	Operations Research Society of America
OSD	Office of the Secretary of Defense
OSD(PA&E)	Office of the Secretary of Defense (Program Analysis and Evaluation)
PBA	Predictive Battlespace Awareness
PLO	Palestine Liberation Organization
PLO	Palestine Liberation Organization
PME	Professional Military Education
PMSEII	Political, Military, Economic, Social, Infrastructure and Information
POA&M	Plan of Actions and Milestones
POW	Prisoners of War
PPBS	Planning, Programming and Budgeting System
PRISM	Personnel Requirements Information System Methodology
QDR	Quadrennial Defense Review
R&D	Research and Development
RDO	Rapid Decisive Operations
S/W	Software
SES	Senior Executive Service
SIAM	Space and Information Analysis Model
SJTF HQ	Standing Joint Task Force Headquarters
SPA	Systems Planning and Analysis, Inc.
STI	Simulation Technologies, Inc.

TBE	Teledyne Brown Engineering
TV	TeleVision
UAV	Unmanned Aerial Vehicles
UK	United Kingdom
UN	United Nations
UNSCOM	United Nations Special Commission
US	United States
USA	United States Army
USAF	United States Air Force
USAFE	United States Air Forces in Europe
USAWC	US Army War College
USMC	United States Marine Corps
USSOUTHCOM	US Southern Command
V&V	Verification and Validation
WG	Working Group
WMD	Weapons of Mass Destruction

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Appendix B - Terms of Reference

1. Background. The Fall 2000 "Advancing C4ISR Assessment" Special Meeting highlighted the growing sense of the military community that DoD is moving beyond traditional attrition based warfare to something called effects-based warfare. However, many questions exist regarding the meaning, feasibility, and value of an effects-based warfare or operations approach from a military standpoint. From the MORS view, the questions are in the analytic realm -- in order to understand the potential for an effects-based operation approach, we need to evaluate the "state of the practice" for analyzing Effects-Based Operations.

Effects-Based Operations has different meanings to different people. Part of the challenge is to understand Effects-Based Operations within the context of

- A strategic and operational framework for planning, executing, and assessing military operations designed to produce distinctive and desired effects that, in conjunction with other elements of national power such as economic and political actions, compel positive political outcomes.
- The adaptive application of military, and other, capabilities to realize specific, desired operational and strategic outcomes in peace and war in the face of friction, ambiguity, uncertainty, and adaptive adversaries.
- A systematic approach to the continuous operational cycle of analyses, planning, execution, and assessments based on realizing outcomes through all four types of effects listed below, as distinguished from operations effectively focused on direct effects alone or specific levels of destruction of individual targets.
 - Direct effects on adversary military and other capabilities
 - Indirect effects on adversary and other assessments and actions
 - Undesired effects
 - Unexpected effects

The analysis of Effects-Based Operations is not as straightforward as attrition-based analysis. In addition to physical aspects, the behavioral and "reason" aspects must be addressed. Many questions arise, such as:

- What are the shortfalls in current attrition-based models and how can Effects-Based analysis help?
- What is the difference in how we approach Attrition-Based vs. Effects-Based military operations and analysis?
- How are the Measures of Merit impacted?
 - What is the analogue to the Joint Munitions Effectiveness Manual in Effects-Based analysis?
- How do we deal with Nth order effects?

- How do we deal with the probabilistic aspect of Effects-Based analysis answers?
- What is the distinction between doing Effects-Based analysis for fixed, static target vs. dynamic systems?
- What research and experiments are implied or needed?
 - What fundamental scientific research is necessary to support Effects-Based Operations modeling and simulation, decision support aids, and other requirements?
- What new skill sets and relevant knowledge are needed to do Effects-Based analysis?

2. Goals and Objectives. Many of the organizations both inside and outside the DoD community are interested and involved in employing and analyzing Effects-Based Operations. The goal of this meeting is to provide an opportunity to bring people from those organizations together to share their work, develop a common view of the state of the practice, expose members of the broader analytic community to their needs, and identify shortfalls and potential solutions.

The objectives of this special meeting will be to:

- Achieve an understanding of the analytical challenge of Effects-Based Operations
- Explore what tools, data, and metrics exist or need to be developed
- Relate the concept to what already exists.

3. Approach. The meeting will start in a mini-symposium format that will include operationally based panel discussions as well as keystone papers. The purpose of this portion is to bring all participants up to speed on the state of the practice. This will be followed by a two-day workshop where the participants will be meet in working groups to further examine specific topics. Working groups will prepare a report on their activities to present to other workshop participants at the last session of the workshop. A call for papers will be posted on the MORS website to seek out abstracts for high quality papers on EBO. The responses will be reviewed and a select group of people will be requested to prepare and present papers.

3.1 Working Groups

The workshop attendees will be organized into six working groups plus a synthesis group. The working group structure is detailed below.

3.1.1 Working Group 1: Decision Support for Operations

Chair: Col Jose Negron

Co-Chair: Bruce Harris

Advisor: Dr. Cy Staniec

This working group will examine the use of analysis to support the planning and assessment of Effects-Based Operations.

3.1.2 Working Group 2: Decision Support for Force Structure Planning

Chair: LtCol Kirk Yost

Co-Chair: James Bexfield, FS

Advisor: Dr. Andy Loerch

This working group will examine the use of analysis of Effects-Based Operations to support acquisition decisions and force structure planning.

3.1.3 Working Group 3: Wargaming, Experimentation, and Exercises

Chair: Col Steven Pennington

Co-Chair: CDR Mike Waldhauser

Advisor: Dr. Russ Richards

This working group will examine how Effects-Based Operations can be characterized in wargaming, experimentation, and exercises.

3.1.4 Working Group 4: Indicators of Success

Chair: Gary Wheatley

Co-Chair: Corrine Wallshein

Advisor: Chuck Taylor

This working group will discuss indicators of success in Effects-Based Operations. It will also discuss how these indicators might differ from the traditional measures of merit for Attrition-Based Operations.

3.1.5 Working Group 5: Fundamental Sciences

Chair: LtCol Steve Rinaldi

Co-Chair: Jeff Cares

Advisor: Dr. Al Brandstein

This working group will examine fundamental scientific research required to support development of Effects-Based Operations data, decision support tools, analysis methodologies, models, simulations, etc.

3.1.6 Working Group 6: Effects Based Analysis of Counterterrorism

Chair: Dr. Randy Pherson

Advisor: Dr. Bob Sheldon

This working group will examine analytic tools and techniques applicable to conceptualizing, planning, and executing Effects-Based campaigns to counter terrorism.

3.1.7 Synthesis Group

Chair: Dr. Stuart Starr

A synthesis group will identify the common themes that tie together the efforts of the subject area working groups and provide feedback to the groups on a continuing basis.

4. Agenda. (Tentative)

Day/Time

Activity

Monday, 28 January 2002

1700 Working Group Chair and Co-Chair Warm-Up Session

Tuesday, 29 January 2002

0700	Registration and Continental Breakfast
0800	Call to Order and Opening Remarks
0805	Sponsor's Welcome and Workshop Kick-Off
0830	Keynote
0930	Break
0945	Other Presentations (TBD)
1200	Lunch in Working Group Rooms
1330	Other Presentations (TBD)
1700	Workshop Kickoff
1700-1900	Mixer

Wednesday, 30 January 2002

0800	Special Presentation
0900	Working Group Session #1
1015	Working Group Session #2
1200	Lunch
1330	Working Group Session #3
1500	Working Group Session #4
1630	Indicators of Success Interim Report
1700	WG Chair and Co-Chair Hot Wash

Thursday, 31 January 2002

0800	Special Presentation
0900	Working Group Session #5
1200	Lunch
1330	Working Group Outbriefs: WG 1, 2, 3
1500	Working Group Outbriefs: WG 4, 5, 6, Synthesis
1700	Adjourn

5. Attendees. Attendance will be by invitation only. The attendees will be from government, government contractor, and academic organizations involved in the analysis of Effects-Based Operations including the Air Force, Navy, Army, Marines, OSD, J8, ASD (C3I), Navy Warfare Development Command (NWDC), J9/JFCOM, JWAC, SOCOM and others. The inclusion of the State Department and National Security Council is also possible. Selected representatives of the TTCP nations (UK, CA, AS, NZ) have been invited to participate.

6. Products.

Several products will be generated from this workshop:

- A briefing will be offered to the sponsors within 30 days.
- An article summarizing the meeting and its findings will be produced and submitted to *PHALANX* in time for the next deadline after the meeting.

- A general session presentation will be made at the 70th MORSS.
- A monograph of papers will be provided based on the quality of papers.

7. Milestone table

- Concept paper- final draft Jan 5, 2001
- Discussions with sponsors/reps Jan 12, 2001
- Identify Program Chair(s) Feb 15, 2001
- TOR to Exec Council for approval April 2001
- Identify working group chairs May 17, 2001
- Post Call for Papers on MORS website and e-mail to MORS reflector April 27, 2001
 - Particularly sought: serious analytical and technical papers sharpening our critical understanding of Effects-Based Operations
- Paper abstract deadline June 30, 2001
- Meeting: Jan 29-31, 2002
- Post meeting sponsor's brief March 1, 2002
- *PHALANX* Article due February 15, 2002

8. Proponents. Proponents of this meeting are the Air Force (AFSAA), Joint Staff (J8 and J9/JFCOM), Navy (N81), and OSD (Office of Net Assessment)

9. Organizing Committee.

Chairs: Dr. Jackie Henningsen, MG Cash

Co-Chairs: Dr. Dick Hayes, Ms. Sue Iwanski

Synthesis Group Chair: Dr. Stuart Starr

Army: Maj Rob Shearer

Air Force: Col Steven Pennington, LtCol Jim Tubbs, LtCol Steve Rinaldi

Navy: CDR Jim Beatty

OSD Net Assessment: Col David Anhalt

OASD (C3I): Dr. Dave Alberts, Mr. Chuck Taylor

J8: Mr. Pete Byrne, LtCol Michael Butler, Lt Col Leonard Heavner

J9/JFCOM: Dr. Russ Richards (MITRE)

JWAC: Mr. Frank Mahncke

NWDC: CDR Mike Waldhauser

MORS: Brian Engler, EVP; Natalie Strawn Kelly, VPA

At Large: Dr. Paul Davis, Dr. Jerry Kotchka, Mr. Jim Bexfield, Dr. Bob Sheldon, Dr Ed Smith, Dr. Roger Burk

MORS Bulldog: TBD

10. Administrative:

Name: Analyzing Effects-Based Operations

Dates: January 29-31, 2002

Location: Booz Allen Hamilton, McLean, VA

Classification: SECRET

Registration fees are as follows:

Mini Symposium (Day 1) only: U.S. Federal Government \$100; all others \$200.

Mini Symposium & Workshop: U.S. Federal Government \$200; all others \$400.

Attendees: 150 people, by invitation

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A Dialogue on Analyzing Effects Based Operations (EBO)

Dr Jacqueline Henningsen, SES, MORS Fellow of the Society Director, Air Force Studies & Analyses Agency

Introduction

This edition of *PHALANX* contains several articles on the MORS Workshop on EBO that was held January 29-31, 2002. MG Dean Cash, Director, Joint Experimentation, Joint Forces Command and I were the general chairs of this meeting. As always, the hard planning and development of the meeting was performed by the technical co-chairs Ms Susan Iwanski and Dr Dick Hayes as well as a team of outstanding working group and synthesis team leaders who are identified in Sue and Dick's article. I have asked the following presenters to highlight some points in a dialogue format: MG Dean Cash, Director, Joint Experimentation, Joint Forces Command; Mr Len Hawley, former Deputy Assistant Secretary of State; Maj Gen Dave Deptula, Director of Plans and Programs, Headquarters Air Combat Command; Mr Barry Watts, Director of Program Analysis and Evaluation, Office of the Secretary of Defense

Dr Henningsen: MG Cash, you presented some very compelling ideas for consideration to the attendees. In particular, you challenged them to not let an "it's not invented here" view slow progress in implementing effects based operations approaches. Would you provide some thoughts and recommendations for the analytic community with regard to analysis of EBO.

MG Cash: The new policy of dissuasion as articulated by the SECDEF will require a new way of thinking about conflict resolution and the application of National power. The concept of Effects Based Operations (EBO) may be this new way of thinking that will allow us to achieve this end-state of dissuasion. Presently we do not have the analytical tools we need to measure EBO. Specifically we need:

- Tools to measure the magnitude and impact of potential problems for national security;
- Models that can play out a long temporal dimension (current models have a problem with time);
- A way to measure national will;
- A way to decide how you achieve decision superiority and how it is measured.

(See DIALOGUE, p. 26)

Analyzing Effects Based Operations (EBO) Workshop Summary

Dr Richard Hayes, Evidence Based Research, Inc., rehayes@ebrinc.com

Ms Sue Iwanski, Systems Planning and Analysis, Inc., siwanski@spa-inc.net

Background

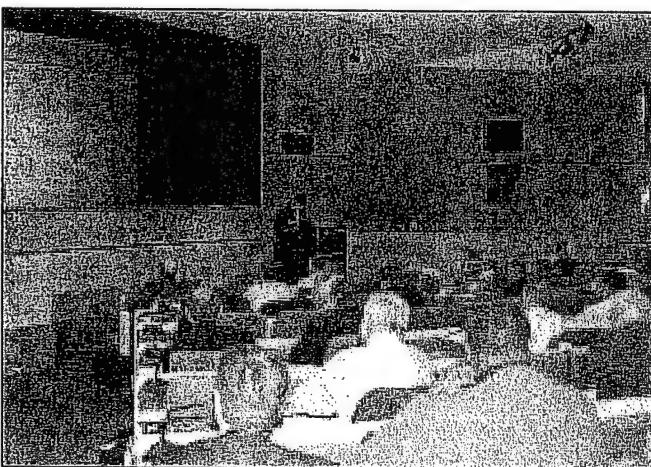
A MORS Workshop on EBO was held 29-31 January 2002. 177 analysts and decision makers participated. This number included nine foreign nationals and produced 61 new MORS members. This article summarizes the purpose, findings and recommendations of the Workshop.

Purpose

The original concept for MORS holding a workshop on Analyzing Effects Based Operations (EBO) arose more than a year ago and focused on the very real question of whether EBO was a useful concept at all. Over the past year the concept has been maturing and more and more organizations have begun taking it seriously. Nevertheless, the four key issues the Workshop was asked to address were:

- What does the phrase "Effects Based Operations" mean?
- What analytic challenges does it present to the Operations Research (OR) community?
- What approaches and tools already exist that offer promise in meeting those challenges?

(See EBO WORKSHOP, p. 23)



EBO WORKSHOP

(continued from p. 1)

- What actions should the OR community recommend in order to ensure quality analyses in support of Effects Based Operations?

The Workshop was successful in generating quality responses to all four issues, though the results also highlight the fact that a great deal more needs to be done. The effort profited greatly from rich work group efforts. The working group structure is shown in Figure 1.

What is EBO?

Consensus emerged that warfare, particularly effective warfare, has always been effects-based. Sun Tzu, Genghis Khan, Napoleon, Eisenhower and Schwartzkopf all would be familiar with the principles that (1) warfare should include all the instruments of national power and that (2) each instrument should be applied in a way that maximizes its desirable impacts, minimizes undesirable ones, and complements actions taken in other arenas. These basic principles, which define the essence of EBO occur in a context that makes them particularly relevant today. First, we have the means to gather, integrate, and apply more data, information and knowledge than analysts and policy makers in earlier eras — we are in the Information Age. Second, we live in a world that is more tightly coupled than ever before, creating opportunities and challenges for both direct and indirect, desirable and undesirable effects. EBO permits us to seek more efficient ways to achieve national goals and allows us to consider shaping the environment in order to minimize challenges to US interests. EBO does not exclude, and cannot properly be contrasted with, either kinetic weapons or attrition, as they are tools that may be used to achieve desired effects. Ultimately, the “effects” sought will be behavioral, but that may arise from altering the adversaries’ capabilities or will. EBO does tend to focus greater attention on will, but not to the exclusion of altering the capabilities of adversaries, partners or neutrals.

Two crucial differences between EBO and the ways we have been thinking in the past emerged from the discussions in the workshop:

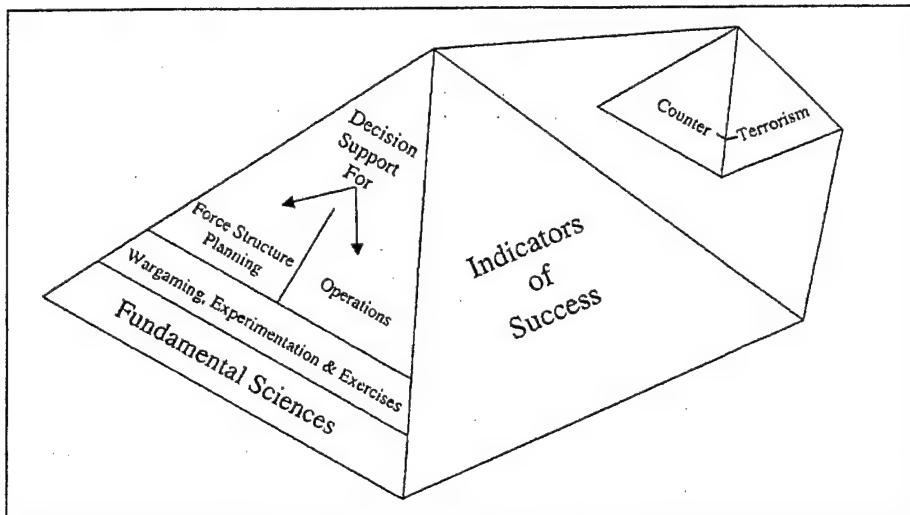


Figure 1. Working Group Structure

- Effects Based Operations challenge us to move from an era of increasing Jointness to an era of “Meta-Jointness” that integrates DoD’s actions into coherent sets of actions that involve a broader set of participants (e.g., interagency and coalition partners, International Organizations (IOs), Non-Governmental Organizations (NGOs)).
- Effects-Based Operations require both greater knowledge and greater capability to deal with uncertainty than traditional military operations.
- In the words of plenary speakers at the Workshop, EBO therefore becomes “a way of thinking” (Major General Deptula, USAF), “a common frame of reference between DoD and other agencies” (Graham Kessler, J9, JFCOM), and it “coordinates sets of actions directed at shaping the behavior of friends, foes, and neutrals, in peace, crisis, and war” (Ed Smith, Boeing).
- Key Attributes of EBP and the Challenges they Imply
 - Effects Based Operations draw most of their key characteristics from the environments in which they are needed. Classic EBO problems are:
 - Multi-disciplinary: with partners, adversaries and neutral parties involved and perceived to have important interests in the situation.
 - Multi-dimensional: political, military, social, economic, information, legal and humanitarian factors are often all highly relevant.
- Multi-echelon: cutting across the boundaries between strategic, operational and tactical arenas.
- Perception driven: each actor will see a somewhat different situation and is likely to interpret actions in somewhat different ways.
- Dynamic: changing over time, such that even the interests and goals of the parties will change during the operations.
- Characterized by adaptive behavior: all the parties are likely to learn during an EBO, or from a prior EBO, and alter their behaviors accordingly.
- Non-linear: such that small actions or changes in behaviors may lead to dramatic impacts.
- Involve both massive and sparse data regions: some aspects of EBO occur in problem spaces with so much data that they defy integration and comprehension, but other important aspects occur where little or no quality data exist.
- Uncertain: despite the fact that EBO are often associated with floods of data and information, they are also typically associated with great uncertainty about key items of information and knowledge.
- Probabilistic: simple cause and effect patterns may be very difficult to detect given the number of relevant factors and the degree of uncertainty, forcing EBO analysts to employ probabilistic approaches and tools.

In short, EBO today take place in a

(See EBO WORKSHOP, p. 24)

EBO WORKSHOP

(continued from p. 23)

highly complex, multi-dimensional environment. In addition, ideal EBO are highly efficient — achieving basic goals with limited investments and calculated risks to lives and national treasure. Taken together, the attributes of EBO and the situations in which they take place constitute a major challenge to the analytic community.

The Workshop paid particular attention to Measures of Merit (MoM) and indicators of success. These represent a meaningful challenge in EBO. First, they were seen as heavily situation dependent, though the hope was expressed by those working the issue that classes of situations could be associated with families of metrics. However, the most profound challenge in this arena is a cultural change within DoD — persuading military decision makers that they must ultimately support Measures of Policy Effectiveness (MoPE), not limiting themselves to Measures of Force Effectiveness (MoFE). This, of course, greatly complicates analyses to support EBO.

Existing Approaches, Tools and Techniques

On one level, consensus existed across the plenary sessions and the working groups about the kinds of approaches that are needed to perform analyses in support

of EBO. Qualitative approaches may be necessary because not all the issues can be handled using quantitative tools. Analyses often will be exploratory, ensuring a rich understanding of the problem space and helping us see what can happen rather than predict precisely what will happen. Analysis will be probabilistic rather than deterministic. Decomposition will be employed in order to make research issues more tractable, but reaggregation to create a holistic understanding of the problem will remain essential and challenging. Paul Davis' (RAND) call for "multi-perspective, multi-resolution models" resonated with many of the workshop participants, who see EBO as too difficult to support with individual tools. Optimization may be neither practical nor essential. Instead, decision makers are likely to opt for different decision logics, such as strategies that allow them to avoid disaster with high confidence while increasing the likelihood of success, or buying more time to reshape an unfavorable situation. Approaches that help to visualize EBO, to track resource allocation within EBO, and to trace effects (second and third order, cascading effects, etc.) also would be valuable.

Several specific tools that show promise for EBO applications were identified. The most mature were built on influence networks, which represent expert opinions that can be examined in detail and experi-

mented with through sensitivity analyses. The most mature of these have been implemented in conjunction with colored Petri nets to map them into integrated plans of action. Computational social science tools also were identified as a good match to the EBO arena, as were complex adaptive systems employed in state space analyses (chaotic control theory and evolutionary game theory), but these tools have not as yet been applied directly in the EBO arena. Initial efforts using agent based models and neural networks were reported as promising in briefings to working groups, but are still in the research and development stages. Leontief input-output analysis, well established in economic analyses, were shown to be a good match to the EBO problem space, but cannot be applied unless quality data are available and the behaviors (changes in resource allocations) of non-market states can be forecast intelligently.

Finally, a number of research techniques were endorsed by the plenary speakers and the working groups. These included mining history (both to generate rich understandings of specific situations and the actors relevant to them, and to understand the dynamics associated with different instruments of influence and power), structured games (both war games and games that focus on broader interactions), and structured campaigns of experimentation.

Table 1.

PLENARY SESSIONS	TOPICS	PRESENTER
Keynote Presentation	A Policy-Maker's Perspective on EBO	Mr Len Hawley, Former Assistant Sec of State
Special Presentation	Effects-Based Operations- Change in the Nature of Warfare	Maj. Gen David Deptula, USAF, ACC/DO
Special Presentation	Effects-Based Operations: An Operator's Perspective	General Charles Wilhelm, USMC (Ret)
Technical Presentations	EBO: A Grand Challenge for Analysis	Dr Paul Davis, RAND
	Effects-Based Course of Action Analysis in Support of Wargames	Dr Lee Wagenhals, GMU
	EBO Concept	Mr Graham Kessler, JFCOM
	Computational Social Science, Operations Research & EBO	Dr Desmond Saunders-Newton, ODUSD/AS&C
	Analytic and Philosophical Imperatives of EBO	Dr Michael Senglaub, Sandia National Labs
	Input-Output Modeling for EBO	Capt. Anthony Snodgrass, AFOTEC/TSE
	From NCW to EBO	Dr Ed Smith, Boeing
	Measuring the Effects of Military Operations	Mr Barry Watts, OSD (PA&E)

Workshop Recommendations

Effect Based Operations, as a broad organizing concept, appears promising as an approach that will help decision makers in DoD and other organizations in the national security arena to protect US national interests and achieve US goals. The Workshop identified a number of tools and approaches that appear promising to support EBO. However, this will require several important changes. These include:

- Education of both the decision making and analytical communities about EBO, including what it means and what it will take to implement it.
- Improved sharing of information, knowledge, training, planning, execution and feedback across all the organizations that must participate in an EBO (e.g., the intelligence community, DoD, the National Security Council, and the other departments and agencies in the national security committee).
- Adoption of measures of policy effectiveness and indicators of EBO success as the dominant focus of analysis.
- Deployment of multi-disciplinary analytic teams with military headquarters employing EBO to ensure responsive

support, educating the analysts about real world problems, and enabling effective linkage to technical communities.

- Broadening and deepening the expertise (substantive and analytical) available to support EBO, including tools for information sharing, research and collaboration. This includes more interdisciplinary work that involves more social scientists, area specialists and non-military practitioners (e.g., NGO, IO, business) in the community, broader training of OR professionals in the "soft" areas, as well as creating the capacity (reach back, reach out, intermediary organizations such as CINCPAC's Virtual Information Center) to use their expertise during EBO.
- Creation of databases and data structures designed to support EBO and the networks EBO seeks to impact. At the same time, adaptation of data mining techniques to permit efficient application of these techniques.
- Support efforts to develop and employ EBO analyses with an integrating mechanism, similar to the Command and Control Research Program of the ASD/C3I, that acts to stimulate, coordinate and integrate relevant activities

Table 2.

WORKING GROUP	LEADERSHIP
Decision Support for Operations	WG Chair: Col Jose Negron, DARPA WG Co-Chairs: Mr Bruce Harris, DRC Advisor: Dr Cy Staniec, Northrop Grumman IT
Decision Support for Force Structure	WG Chair: Lt. Col Kirk Yost, OSD WG Co-Chairs: Mr Jim Bexfield, FS, IDA Advisor: Dr Andy Loerch, GMU
Wargaming, Experimentation, and Exercises	WG Chair: Col Steve Pennington WG Co-Chairs: CDR Mike Waldhauser, NWDC Advisor: Dr Russ Richards, MITRE
Indicators of Success	WG Chair: RADM Gary Wheatley (ret), EBR WG Co-Chairs: Corinne Wallshein, AFSAA/SAG Advisor: Mr Chuck Taylor, Joint C4SIR DSC
Fundamental Sciences	WG Chair: LtCol Steve Rinaldi, AF/XPQI WG Co-Chairs: Mr Jeff Cares, Alidade Consulting Advisor: Dr Al Brandstein, MCCDC
Effects Based Analysis for Counterterrorism	WG Chair: Dr Randy Pherson, EBR WG Co-Chairs: LtCol Eileen Bjorkman, DMSO Advisor: Dr Bob Sheldon, Emergent-IT
Synthesis Group	WG Chair: Dr Stuart Starr, FS, MITRE WG Co-Chair: Dr Roy Rice, TB

across government, industry, academia and coalition partners. This should include activities to create an EBO community, such as websites, workshops, symposia and publications.

- Develop a "tool chest" to support EBO analyses that includes easily manipulated, specialized modeling and simulation tools, computational social science tools, data mining, colored Petri nets, neural networks, and specialized tools developed in particular application arenas (e.g., counter-terrorism, persuasive communication, economics). This tool chest should be assembled in evolutionary fashion, creating a core capability from "best of breed" products and refining and expanding the tool chest to reflect user feedback and the results of research.
- Establish, for both exploratory research and training purposes, a series of wargames and experiments to explore the EBO field, make practitioners more comfortable with the topic, and allow rapid analyses of new challenges and situations where shaping or coercive diplomacy appear promising.

We still have a long way to go to address the issue of Analyzing Effects-Based Operations. One of the Synthesis group recommendations was that MORS should schedule a follow-up meeting in two years to discuss progress in Analyzing EBO. A summary brief of the current workshop will be presented to the Sponsors and an outbrief will be given at the 70th MORS.

Meeting Description

The meeting was held at Booz Allen & Hamilton on 29-31 January 2002 and was structured as a combination mini-symposium and workshop. The mini-symposium on the first day featured papers to bring us up to speed on the state of the art on EBO thinking. The General Chairs Dr Jackie Henningsen, FS, Director, Air Force Studies and Analyses and MG Dean Cash, USA, USJFCOM/J9, both provided opening remarks to kickoff the meeting. Table 1 shows the list of speakers and presentations that followed. The keynote address was given by Mr Len Hawley, former Assistant Secretary of State to provide a policy-maker's view. Practical perspectives on EBO were provided by Major

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EBO WORKSHOP

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General Deptula, USAF and General Charles Wilhelm, USMC (Ret), who has served as CINC, USSOUTHCOM and currently works with JFCOM J-9 in developing and experimenting with new concepts such as EBO. Notably, General Wilhelm was Commanding General MCCDC when the Marine Corps became an official sponsor of MORS. Paul Davis of RAND and Lee Wagenhals of George Mason University gave broad presentation that linked EBO to analytic challenges and suggested classes of potentially useful analytic tools. The sequence of technical presentations that followed led into progressively more detail on analyzing EBO. The day concluded with Ed Smith's paper that discussed linking NCW to EBO.

The mini-symposium was followed by a two-day workshop. This began with a special presentation by Mr Barry Watts (OSD, BA&E) on Measuring the Effects of Military Operations. Then the participants met in working groups to examine specific topics. The six working groups were: Decision Support for Operations; Decision Support for Force Structure Planning; Wargaming, Experimentation and Exercises; Indicators of Success; Fundamental Sciences; and, Effects Based Analysis for Counterterrorism. As with all MORS special meetings, a Synthesis Group was formed to collect and summarize insights from each of the working groups. Table 2 shows the Working group leadership which included an excellent group of energetic people. Working group reports were briefed out on Thursday afternoon. Some briefs and papers presented during the Plenary session can be found on the MORS website at http://www.mors.org/meetings/ebo/ebo_presentations.htm.

Summary

As a consequence of the Workshop, there is enhanced understanding of the nature of this highly complex and multi-dimensional problem. In addition, we are beginning to gain confidence that our traditional approaches to such problems are viable. However, we are keenly aware of the major challenges that remain in assembling and applying the needed expertise, tools and data to analyze real world operations. *

DIALOGUE

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Finally in light of what we have learned so far, the EBO concept is having a profound impact on other concepts such as Rapid Decisive Operations (RDO). In the context of EBO, perhaps "rapid" is not the right modifier or metric. Rather the EBO must be harmonized across time to achieve each desired effect(s) in an appropriately "timely," as opposed to "rapid," action.

Dr Henningsen: Mr Len Hawley, as a former Deputy Assistant Secretary of State, you must have reviewed Secretary of Defense Rumsfeld's February speech at the National Defense University concerning his views on *Defense Transformation* with great interest. It seemed to me there were major connections to the points you made in your MORS keynote address – *A Policy-maker's Perspective on Effects Based Operations* – regarding the newly important role of effects-based analysis in crisis decision-making. Based on Secretary Rumsfeld's comments, do you see an increasing role for effects-based analysis in helping policy-makers successfully deal with crises in the future? In particular, you emphasized that when in the midst of a crisis, policy-makers want flexibility, as opposed to a fixed plan, in applying a strategy of coercive diplomacy against an adversary. What role can effects based analysis play at the policy level in developing a range of options that would possibly reverse an adversary's thinking about continuing actions that threaten U.S. interests? How can we best communicate the range of options and choices in a crisis?

Mr Len Hawley: In his recent speech on *Defense Transformation*, Secretary Rumsfeld enthusiastically illustrated the primary needs of a policy-maker in times of crisis. Looking to the future from his perspective, the Secretary stated that what is needed now at the threshold of the 21st Century is a "new way of thinking and new way of fighting" in response to a wide range of more unpredictable and shrewd adversaries that will confront us in the future. After listening to the Secretary's comments, it seems to me that effects based analysis will play a central role in meeting his challenge to the military to think differently about conducting operations in the future.

Secretary Rumsfeld reaffirmed that the core mission of the U.S. armed forces in the future will continue to be winning the nation's wars. However, with the emer-

gence of more unpredictable and unexpected threats to U.S. national security interests, the Secretary stressed that the American military needs to be better prepared for these unpredictable threats by adopting "new ways of thinking and new ways of fighting." He cautioned that what has worked well recently in Afghanistan will probably not work elsewhere on the next battlefield of the 21st Century. He further warned that future adversaries would increasingly have access to a variety of weapons of mass destruction, and some may threaten the American homeland.

In calling for a transformation in current Defense concepts, Secretary Rumsfeld maintained that the military's most serious deficiency in today's force was that it was not prepared to deal with an adversary who is unforeseen by Defense planners today and whose actions will likely be very unpredictable in a future crisis. Such new, unexpected and dangerous adversaries, the Secretary declared, must be dissuaded, deterred, and defeated without undue cost to American interests abroad or attacks on the U.S. homeland.

As an experienced U.S. policy-maker, Secretary Rumsfeld reinforced the traditional U.S. strategic approach to crisis prevention and response – a strategy of coercive diplomacy designed to successfully confront an adversary who threatens U.S. national security interests. Success in coercive diplomacy in the complex strategic environment of the coming years ahead, requires that policy-makers have in hand a range of options that can effectively dissuade, deter or compel potential adversaries from taking action, especially those who would consider using weapons of mass destruction against U.S. interests. In the future, the United States must use all instruments of national power, the Secretary asserted, to reduce or contain these potential adversaries through persistent and effective coercion. Obviously, this approach spotlights the need for better intelligence capabilities to better understand future adversaries so policy-makers can take the most effective action in times of danger.

The Secretary's comments vividly reveal a policy-maker's compelling need for flexibility in a crisis – they demand effective options and realistic choices, for both prevention and response, to resolve a crisis on the best terms. U.S. policy-makers seek even greater flexibility when confronted by a dangerous and wily enemy, especially

those who hold uncompromising commitment, such as Usama bin Laden, to kill Americans and harm U.S. interests anywhere in the world. As Secretary Rumsfeld stated, all tools of national power must be available to change an adversary's thinking. These tools include a range of measures including diplomatic pressure, legal action, military coercion, law enforcement, covert operations, financial sanctions, and whatever else that can be brought to bear effectively. Clearly, the Secretary wants the military to have more capable forces to serve this purpose in protecting U.S. security interests against the new and dangerous adversaries in the future. This policy requirement is the essence of Defense Transformation.

An important new approach in meeting the Secretary's challenge is effects-based analysis. That's because this new way of thinking seeks to forecast how a defiant adversary would respond to a range of U.S. (or those of a coalition) coercive actions – both military and non-military measures – to bring about decisive results without unduly compromising other U.S. interests at stake. The central questions of an effect-based analysis – note they are the same questions asked by policy-makers in a crisis – are as follows: How would an adversary react if the U.S. were to take specific actions? How long will it take to achieve the desired effects on him? What are the possible unintended consequences? What is the range of realistic choices available that can be used in the near term?

How best can these choices be communicated to policy makers? Here I should stress that policy-makers make decisions based on personal value judgements. For example, in most cases policy-makers would value options that can bring about decisive results more quickly and decisively, within say a week's time rather than a year's time. Unfortunately, the effects of most instruments of national power on an adversary, such as diplomatic pressure, are difficult to forecast precisely, but this does not relieve the requirement for such estimates to be made for policy-maker consideration. That said, accuracy of forecasts is not always the most critical factor here for policy-makers; instead, an effects based analysis, using a "a system of systems" approach, can be extremely valuable to policy-makers since such an analysis can help them understand patterns of behavior and the dynamics of coercion in these complex crisis situations. Accordingly, with a good

effects based analysis, crisis decision-makers can make concrete judgements much more confidently...and achieve decisive results without unduly compromising other U.S. interests at stake.

"U.S. policymakers seek even greater flexibility when confronted by a dangerous and wily enemy, especially those who hold uncompromising commitment ... to kill Americans and harm U.S. interests anywhere in the world."

Dr Henningsen: Maj Gen Deptula prior to your current position as Director of Plans and Programs, Headquarters Air Combat Command, you were an Air Force point man for ENDURING FREEDOM. You have long advocated the value of an effects based operations approach to modern warfare. In your presentation you traced EBO efforts from DESERT STORM to current operations. Some say that EBO is not new, it is just capturing the way the best military leaders have always approached conflict. Others see a major shift in the role of military leaders related to EBO style thinking. Would you provide some insights on these two seemingly opposing views. What can the analytic community do to help the warfighter know when the effects being created are getting you closer to the objectives.

Maj Gen Deptula: The fact that effects-based operations (EBO) is not new, and yet requires a major shift in thinking, gets to the heart of its importance for modern military operations. These are not mutually exclusive, in fact, they are mutually rein-

forcing ideas.

Astute military leaders have always known that superior alternatives to attrition existed. When confronted with numerically superior forces of the great Persian king, Darius, at the Battle of Arbela in 331 BC, Alexander the Great led his cavalry in a daring assault on the king's command position in the rear of his military formations. When the king and his entourage fled, the Persian-led troops lost heart and were quickly vanquished. Even the forward-thinking airmen who in AWPD-1 outlined the logic of strategic precision daylight bombing were thinking about effects. Unfortunately, their effects-based strategy confronted the technological innovation of radar that turned the war in the air into an attrition contest. Airmen learned that only through the establishment of air superiority could we achieve true effects-based operations.

One can find many other examples in history, but in most cases, effects-based strategies and tactics were employed by what were later called military geniuses. Thus, they were a rare occurrence. Especially in the two dimensional, highly frictional world of surface operations, it remains very difficult to gain a positive political outcome without confronting the enemy's strength directly. Things have changed, however. The consistent increase in the importance of aerospace and other technologies to US national security policy has accelerated in the last couple decades particularly with the advent of stealth, precision, and global surveillance. These new capabilities provide a more consistent platform from which the strategist can employ an effects-based approach. Given our own overwhelming asymmetric advantage in these areas, we cannot afford to wait until a genius presents us with an effects-based option. We must institutionalize genius by teaching an effects-based approach throughout the Department of Defense, to include civilians.

The key to turning what Alexander the Great and the writers of AWPD-1 knew into a routine way of thinking is through effects-based operations education. No longer must the achievement of an effects-based approach be the purview of geniuses or random chance. Our recent lessons in asymmetric warfare have made it an imperative to realize that all the gains in capability realized now and in the future can be

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squandered by retaining an attrition-based mindset. We can now systematically pursue the maximum strategic effect with a minimum of risk in American lives, time, and treasure. There remains much work to be done in this area, but EBO is the key to translating capability into victory in the twenty-first century.

Dr Henningsen: What can the analytic community do to help the warfighter know when the effects being created are getting you closer to the objectives?

Maj Gen Deptula: Again, modern information age technology holds great promise in presenting tools that can help the commander efficiently and effectively employ force. In the near term, much could be done to help the commander anticipate the physical effects of a particular course of action. Physical effects can be modeled more easily than cognitive effects, and therefore present a more lucrative near-term targets. Specifically I would like to see a tool that takes a particular master air attack plan, models the anticipated physical effects, and iterates that attack over thousands (or a statistically significant number) of repetitions so that the algorithm can converge on certain outcomes—all this before the attack commences. That same tool can help us understand physical effects when we receive updated bomb damage assessment.

The problem of anticipating cognitive effects is more thorny. Ultimately, the joint campaign must effect the adversary's will. Although some work is being done in the area of modeling senior decision maker attitudes, much needs to be done in this area. As fiber-optic bandwidth improves and computing power continues to rise, I can see a day in which the warfighting commander could anticipate enemy strategies—even to the point of achieving Sun Tzu's "acme of skill"—being able to achieve one's objectives without combat.

I'd take that vision one step further. I want to see a set of integrated physical and cognitive effects models that could help this nation achieve its national security objectives without the adversary even knowing that he's been influenced. That's a tall order, but the operations research community has always been able to produce combat-relevant information for the commander, and I suspect that given the right

direction, you'll do it again.

Dr Henningsen: Mr Watts, as Director of Program Analysis and Evaluation in the Office of the Secretary of Defense, you provided a strong dose of painful reality to the conference proceedings. In particular, you reviewed historical wars for evidence that EBO concepts fit certain hypotheses of causality. You did not seem to conclude that the effort to use EBO approaches was in vain, however, unlike MG Cash who recommended we stay above the tactical level, you pointed us toward finding better ways to display target set effects. What advice would you give to analysts trying to advance the art of analysis in relation to EBO?

Mr Watts: It was not my intent to drive thinking on, or analysis of, EBO down to the tactical level. I agree with MG Cash that the focus of EBO should be at the operational level and higher. However, a point I tried to make in my presentation was that when you consider operational-level effects in specific cases such as Operation Desert Storm, precise quantitative measures seldom appear possible in any straightforward or obvious way.

Consider, for example, the effectiveness of air strikes in the 1991 Persian Gulf War against the Iraqi nuclear program. The military campaign objective was to "destroy" Iraq's nuclear capabilities. Pre-war intelligence, we now know, correctly judged that Iraq's "nuclear capabilities" consisted of a program intended to develop nuclear weapons as opposed to fielded capabilities. As of 17 January 1991, when the Coalition campaign began, Iraq did not possess any nuclear weapons.

Given this background, the operational goal of Coalition operations against Iraq's nuclear program were translated into inflicting enough damage on the nuclear program to preclude further progress toward actual weapons for some period of time into the future. While nothing specific was ever written down on how long a period of time strike operations against the program were intended to delay or retard the fielding of weapons, precluding "success" for another five years is probably close to the operational goal the air planners had in the backs of their minds when they started targeting specific nuclear installations and aim points.

As the campaign unfolded, the number

of identified nuclear facilities grew, as did detailed reports of damage inflicted by successive air strikes against those facilities. Toward the end of Desert Storm, the bomb damage assessment (BDA) assessors in Washington, as well as the Central Command air planners, believed that five of the known nuclear targets had been destroyed, two others had been damaged, and only the eighth, which had been identified late in the campaign, remained operational.

From an EBO perspective, the basic question is how to relate this BDA feedback on specific targets and aim points to the higher-level effect of shutting down the Iraqi nuclear program for around five years? While the belief at the time was that the observed target damage implied that the operational goal had been achieved, subsequent on-the-ground inspections by United Nations Special Commission (UNSCOM) personnel such as David Kay revealed that this judgment was inaccurate. UNSCOM inspectors eventually concluded that more than half of the nuclear facilities were not even identified by 28 February 1991, the last day of Coalition offensive operations. In the end, Kay's conclusion was that the Iraqi nuclear program had been halted and dispersed, but had remained largely intact at the end of Desert Storm. In other words, the desired operational effect had not been achieved despite considerable observed BDA against various nuclear facilities. For example, F-117s hit the small reactors at Al Tuwaitha early in the campaign with laser-guided bombs.

Some of the reasons why the desired effect was not achieved in this case highlight the inherent difficulties of getting from tactical BDA, which often can be quantified (e.g., five of the eight targets associated with the Iraqi nuclear program have been destroyed, two damaged, etc.), to higher-level and, I would emphasize, emergent effects. First, U.S. intelligence presumed that the Iraqis would focus their program exclusively on developing plutonium-based weapons. However, plutonium requires reactors, and reactors can be bombed, as the Iraqis discovered in 1982 when the Israelis successfully bombed a French reactor under construction at Al Tuwaitha. Thus, the Iraqis opted to "regress" to uranium weapons, a decision that made "seeing" the Iraqi nuclear program as a whole deeply counter-intuitive for most American intelligence analysts.

Second, at the outset of the campaign,

there were only two nuclear targets in the deck and those, of course, were the two against which the initial American strikes focused. As a result, the Iraqis had time to take key pieces of their program out into the desert and literally bury them. Without staring intelligence coverage of facilities such as Al Tuwaitha, the Iraqis were able to make large parts of their nuclear program disappear as targets early in the campaign.

Third, there was one element of the program-key scientists and their technical knowledge—that was never explicitly targeted. In hindsight, because we did not try to target Iraqi nuclear scientists, the foundation for reconstituting the program largely survived Desert Storm.

I would draw the following conclusions from this example. First, quantifiable BDA may not be a sufficient basis from drawing accurate conclusions about the achievement of higher-level effects against a given target system. Second, the vulnerability of a target system to precision attack can change very rapidly during the course of a campaign.

These are the sorts of conclusions that led me, at the end of my presentation, to suggest that better ways of displaying the effects of our operations might be a sensible line of research and development. I remain deeply skeptical that any display technologies will overcome the inherent uncertainties of getting from tactical BDA to higher-level effects. That said, if a commander has a list of desired higher-level effects, then display technologies that would allow he (or she) to see relative progress against each goal in a single glance would certainly help to shift the focus from BDA bits and pieces to higher-level, emergent objectives. Further, a natural next step would be to look for feedback indicators that might help commanders and planners become aware sooner, rather than later, of discrepancies between inputs and outputs relative to a given goal. In many historical cases, strike operations against particular target systems have quickly reached a state of diminishing returns as the adversary began to adapt. Displays that actively looked for target adaptation over time would be a step forward insofar as the tendency of air planners has been to see target systems as static arrays of aim points.

In the end, my suggestion about developing more dynamic displays is a modest

one. It does not eliminate any of the inherent incommensurabilities and uncertainties I have observed in historical experience between quantifiable results and higher-level effects. However, by helping commanders and planners focus more on higher-level effects, display improvements could advance the state of the art from a practical standpoint.

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Lastly, let me emphasize that I certainly did not mean to argue that EBO is a hopeless enterprise. I believe focusing on higher-level effects is the right direction for the American military. However, we should not kid ourselves about the inherent difficulties of quantifying, much less predicting, emergent effects.

Dr Henningsen: Paul Davis, as a Senior RAND researcher and long term MORSIAN, you, always, help us explore innovative ways to organize our thinking in order to begin productive analysis. In light of the comments of the previous respondents, would you summarize the message from your presentation for our readers?

Paul Davis: First, the EBO movement by warfighters is a great challenge and opportunity for analysts, who have for far too long become comfortable with models that often leave out the art of war and turn everything into numbers dependent of official but very dubious data (such as those about very high “break points”, even for lousy armies). EBO is forcing more insight-

ful analysis.

Looking ahead, then, EBO analysis should take an unusually broad view of “the system”—one that includes cognitive and behavioral factors and allows for quite a range of difficult-to-predict and indirect secondary effects. Because of inherent uncertainties, the view taken should be that the special EBO-related effects are often not something on which to depend, but something that, if attained, could make a major difference. Consistent with that, planning should routinely discuss most-likely, best-case, and worst-case outcomes under the analysis. This would address not only risks, but upside potential. Again, IF the special EBO effects pan out, outcome could be quite good and the plan should build in a branch to exploit that fact quickly, rather than have operations remain deliberate and ponderous. Similarly, in force planning, a new option should be assessed not just under conservative conditions, but so as to recognize the potential for much

better (or much worse) results. Having a capability that would have a huge impact—but only in special circumstances and with a bit of luck—should be seen as potentially very desirable.

Dr Henningsen: There were a number of other speakers who provide a range of insights related to analysis of EBO. For instance, General (ret) Wilhelm, USA, who is a senior JFCOM advisor, noted that he is truly passionate about the need for concepts based requirements. He stated that EBO can be the propellant that fuels transformation. Materials from other presenters were posted on the MORS website or are available from the author.

A special session on the EBO Workshop will be held at the Annual Symposium in June. We originally planned to publish a monograph as an outgrowth of this first special meeting on EBO, but as the meeting evolved it became clear that there is a lot of work to be done before we are ready for a “state-of-the analytic art” publication. At the June Symposium session we will ask the Board to consider provisional working groups for next year on EBO. In conclusion, we frequently end meetings on evolving topics (such as Analysis of EBO) focused on retooling our models, but in the case of EBO, I believe it is even more important to consider how we can retool our thought processes ☀